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Report of the
TWENTY-SIXTH SOUTHERN PASTURE AND FORAGE CROP
IMPROVEMENT CONFERENCE 26
Puerto Rico Agricultural Experiment Station
Rio Piedras, Puerto Rico

May 7-9, 1969

AND

Contributed Papers of Work Groups Meeting in
Conjunction with SPFCIC
May 6, 1969

Southern Forage Breeders' Group
Southern Forage Physiology and Ecology Work Group
Southern Forage Extension Work Group

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Crops Research Division

REPORT OF THE
 TWENTY-SIXTH SOUTHERN PASTURE AND FORAGE CROP
 IMPROVEMENT CONFERENCE^{1/}

Puerto Rico Agricultural Experiment Station
 Rio Piedras, Puerto Rico

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PROGRAM

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Wednesday, May 7, 1969: Marvin E. Riewe, Chairman

8:30 a.m.	REGISTRATION	
9:00	INTRODUCTION BY STATES -- ANNOUNCEMENTS	
9:10	WELCOME -- F. Sanchez Nieva, Associate Director, Agricultural Experiment Station, University of Puerto Rico	
	<u>Symposium:</u> Forage Species: Their Improvement, Management and Utilization in the Tropics	
9:15	Production and Utilization of Tropical Forages for Beef Cattle. Gerald O. Mott, Florida Agricultural Experiment Station, Gainesville, Fla.	2
10:20	BREAK	
10:50	The Production and Utilization of Tropical Grasses in a Mediterranean Environment. Eric A. N. Greenwood, CSIRO, Perth, Australia	1
11:30	Tropical Legume Research in Hawaii. A. Sheldon Whitney, Hawaii Agricultural Experiment Station, Kula, Hawaii	4
12:00	LUNCH	
1:30 p.m.	Potential for Improvement of Tropical Grasses -- A Temperate Viewpoint. David H. Timothy, North Carolina Agricultural Experiment Station, Raleigh, North Carolina	10
2:00	Grass Improvement in the Tropics. Stanley C. Schank, Florida Agricultural Experiment Sta., Gainesville, Fla. ..	14
2:35	Intensive Management of Steep Grass Pastures in the Humid Tropics. Jose Vicente-Chandler, Director, Agricultural Experiment Station, University of Puerto Rico	1
3:00	BREAK	
3:15	<u>Panel Discussion</u> -- Panel: J. Velez-Fortuno, Gene L. Spain, G. O. Mott, J. Vicente-Chandler, Eric A. N. Greenwood, A. S. Whitney, D. H. Timothy, and S. C. Schank	

^{1/} Reported by R. C. Leffel, Permanent Secretary, USDA, Beltsville, Md.

4:45 p.m.	GENERAL BUSINESS MEETING -- M. E. Riewe, Presiding	23
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5:00 ADJOURN

Thursday, May 8, 1969

Bus tour to Corozal and Orocovis

Friday, May 9, 1969

Bus tour to Cidra and Coamo

Registration List 30

Wednesday, May 7, 1969 -- Morning

Marvin E. Riewe, Chairman

Opening Session

The twenty-sixth meeting of the Southern Pasture and Forage Crop Improvement Conference was opened by Conference Chairman Marvin E. Riewe. Chairman Riewe introduced all present by State, government agency, and industry; he announced a business meeting for SPFCIC this afternoon at termination of work session. Chairman Riewe appointed a Nominations Committee of E. C. Holt, J. E. McCroskey, and D. S. Chamblee, Chairman. The Committee Report is due this afternoon at the business meeting. He appointed a Resolutions Committee of W. B. Anthony, R. C. Buckner, and D. E. McCloud, Chairman. This report is due the night of the banquet.

THE PRODUCTION AND UTILIZATION OF TROPICAL GRASSES IN A MEDITERRANEAN ENVIRONMENT

Eric A. N. Greenwood
CSIRO, Perth Australia

Dr. Greenwood's paper, "The Production and Utilization of Tropical Grasses in a Mediterranean Environment", was presented by a series of color slides.

INTENSIVE MANAGEMENT OF STEEP GRASS PASTURES IN THE HUMID TROPICS

Jose Vicente-Chandler
University of Puerto Rico

The topic, "Intensive Management of Steep Grass Pastures in the Humid Tropics", was presented by Dr. Vicente-Chandler via use of slides.

PRODUCTION AND UTILIZATION OF TROPICAL FORAGES

FOR BEEF CATTLE

G. O. Mott
Professor of Agronomy
University of Florida

A viable livestock industry in the tropical areas of the world will depend upon the development of systems of production in which forages will play a major role. In the Latin American tropics, approximately 30% of the total land area is in pasture. This area includes the savannahs of northern Argentina, Paraguay, Brasil and the llanos of Columbia, Venezuela and Guyana. The soils, the temperature, the rainfall both in quantity and seasonal pattern, and vegetation vary widely from place to place but certain characteristics of the environment, the quality of vegetation produced, and the animals are common to most of these areas. The forage species on the natural grasslands are those which have evolved over the centuries under a frequent burning regime but with a minimum of grazing pressure from herbivores. Unlike Africa where the flora of the natural grasslands has been under the influence of a multitude of animal species, the number of grazing animals in the American tropics has been minimal.

The grasses in the American tropics are highly fibrous in character, high in lignin and perhaps also high in organic silica. The soils are low in phosphorous since much of the natural grassland is located on ancient geological formations where the soils are highly leached, low in calcium and other elements essential for plant growth. Calcium and phosphorous deficiencies for the grazing animals are the rule rather than the exception and cobalt and copper supplementation is required in many areas. Protein levels in the indigenous species is extremely low especially during periods of moisture stress.

In a discussion of beef cattle production in the tropics one must think of the entire enterprise as a production system in which the inputs are land, forage and feed, labor, and capital and the output is the extraction rate of marketable beef. There are several components in this system, but I should like to focus our attention on only two main components, namely the animals and their requirements and the feed necessary to meet these requirements. First, let us consider some of the factors which contribute to an extraction rate of only 8 to 10% which is characteristic of the American tropics. This means that out of every 100 beef animals on the farms only 8 to 10 are slaughtered each year. It should be noted that the figure 100 is total beef animals and not just cows of breeding age. As a comparison it is estimated that the extraction rate in the U. S. is about 35%. Most of the factors responsible for the low extraction rate are subject to improvement. A birth rate of 45% or less is quite common and 10 to 15% of those born are lost before they reach weaning age. An additional loss from weaning to

slaughter of at least 5% is a conservative estimate. These losses result in about 18 males and 18 females out of each 100 cows each year. The females will be needed as replacements for the herd leaving 18 males to be grown for slaughter. Since most of the males will not reach slaughter weight until they are 3 to 5 years of age and the females will not have sufficient size until they are three, sufficient feed must be provided for approximately 36 head of 2-year olds, 36 3-year olds and probably some 4-year old animals. Their combined feed requirements must be at least equivalent to the 100 cows in the original group which now reduces our number of marketable animals to 9 out of each 100 total animals.

It becomes rather obvious that there is no one innovation which will provide the answers to the low output of beef in the American tropics but systems of production must be developed which are compatible with the resources available, the climate and most of all the capacity of the ranch manager. Extraction rates of 20 - 25 in the tropics are being obtained through (1) good management, (2) higher levels of nutrition, (3) superior breeding stock, and (4) control of internal and external parasites, on pasture without any supplemental concentrates. A 90% calf crop is feasible, and a killing age of 2 to 2½ years on Guineagrass pastures has been obtained.

The temptation of the North American livestock specialist or agronomist is to attempt the introduction of temperate zone livestock production techniques in toto into the tropical regions. He should be quick to recognize that he is in an alien environment, the grassland species are complete strangers, and the livestock are of different breeds and temperament, and the level of management is simply not available to handle the sophisticated systems of the temperate zones. A cautious approach which analyzes the current situation to determine the factors which are most seriously limiting and for which a solution is available seems more appropriate. It frequently is not necessary nor desirable to attempt an intensified system of management but instead introduce one or two innovations at a time to correct the most obvious deficiencies in the system.

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TROPICAL LEGUME RESEARCH IN HAWAII
A. Sheldon Whitney
Assistant Agronomist
Hawaii Agricultural Experiment Station

Legume research in Hawaii has taken on new importance as a result of changes in the livestock industry in recent years. These changes are largely a result of a shift from marketing range-fattened cattle to feedlot-finished animals (Table 1). This has been a result of the changing price structure. The spread in price between range and feedlot-finished cattle has increased from nearly 7 cents per lb. (dressed-weight basis) to its present 11.6 cents in six years. The accompanying shift to feedlot finishing has permitted a gradual increase in breeding herd numbers, and a greater sales volume, reaching nearly 12 million dollars last year -- making it the third largest agricultural industry in the state. The breeding herd has increased by 25% in the last seven years on a relatively fixed area of pasture (over 1.8 million acres).

High quality pasture has become increasingly important as the cheapest way to maintain healthy gestating and lactating cows, and getting weaned calves off to a fast start. The development of productive grass-legume mixtures has presented the most feasible approach to increasing pasture quality and output in a large proportion of our tropical pastures. I would like to present some of the information we have obtained at the Hawaii Agricultural Experiment Station concerning the characteristics and management requirements of several of the more important pasture legumes.

Kaimi clover (Desmodium canum) was first noted in Hawaii in 1931, but did not become an important pasture plant until the 1940's (1). It now forms an important association with kikuyu, pangola and other grasses in most fertilized low-elevation pastures with a pH of over 5.5. A molybdenum response has also been observed on a highly weathered Humic Ferruginous Latosol (6). The performance of this legume was tested in combination with several grasses in an unreplicated experiment (6) with the results shown in Table 2. The data suggest a stocking rate effect, but animal production in both treatments was impressive, especially in contrast with the low yields obtained on similar but unimproved land.

In the last year, kaimi clover has become the predominant species in pastures attacked by the sod webworm. In many situations where the grass forage was severely decimated, kaimi clover continued to provide forage and increased in density.

In a cinder culture study conducted in small outdoor plots, this legume was grown in association with (a) pangola and (b) napier (elephant) grasses (4). Yields under these conditions were quite low. Nitrogen fixation was 42 lbs. per acre per year in the pangola mixture and 120 lbs. in the napier mixture. There was no observable transfer of N from legume to grass in either case.

Further evidence of N fixation of kaimi clover was obtained in a small plot experiment on a Humic Ferruginous Latosol at 2100' elevation (3). At this altitude, the legume was unable to outgrow a virus disease which caused severe leaf yellowing and deformation, and consequent stunting of growth. As indicated in Table 4, the kaimi-pangola mixture produced only 7500 lbs. of dry matter and 860 lbs. of crude protein per acre per year, and nitrogen fixation was approximately 100 lbs. per acre per year.

Dr. P. P. Rotar has made an extensive collection of D. canum ecotypes, and has made spaced-plant comparisons of these types under several different soil and climatic conditions. The different types range from very woody shrub-like plants with high seed production, to leafy more prostrate types with more vegetative growth. There are also large differences in palatability with consequent differences in their utilization and persistence in grass mixtures. Varying susceptibility to the virus disease mentioned above has also been observed. The selection program is directed toward developing a distinct variety with palatable leafy growth, able to tolerate the virus, and able to make vigorous growth during cool weather.

Another desmodium, D. intortum, has also received extensive study, and under optimum conditions has been shown to be much more productive than kaimi clover. On a highly-weathered soil at 600' elevation, an intortum-pangola mixture yielded in excess of 17,000 lbs. dry matter and 2200 lbs. crude protein per acre per year under infrequent clipping and a high level of phosphorous fertilization (5). In a grazing experiment (6) located on a Humic Ferruginous Latosol at 1000' elevation, the same mixture was tested with (a) lime, (b) a complete fertilizer, and (c) both. The results (Table 3) showed a significant benefit for both lime and fertilizer, with the highest yields resulting from lime plus fertilizer. Animal production in this treatment was over 740 lbs. liveweight increase per acre per year.

The capacity of this legume to fix nitrogen was tested in cinder culture in mixtures with pangola and napier grasses (4). The legume fixed approximately 330 lbs. of N per acre per year under these conditions, and about nine pounds of this was apparently transferred to the associated grass in both mixtures. Forage production was over 20,000 lbs. of dry matter per acre per year, with a crude protein content of 10%.

Another test of intortum in a pangola mixture was conducted at 2100' elevation (3) and cut every 8-13 weeks. The results (Table 4) showed that when the legume was planted in rows 3' apart, yields were slightly lower than when 18" rows were used. At the latter spacing, the mixture yielded nearly 12,000 lbs. of DM and over 1900 lbs. of crude protein per acre per year. The legume fixed about 220 lbs. of DM per year, but very little of this was transferred to the grass. Intortum growth was apparently reduced at average night temperatures below 78°F.

The length of the regrowth period has appeared to significantly influence the productivity and persistence of intortum. The yields reported above were all obtained under lenient clipping or grazing regimes. On the other hand, ranch experience with this legume has been unfavorable whenever continuous or frequent grazing has been permitted. We are currently

studying the influence of two cutting heights and two cutting intervals on mixtures of D. intortum with (a) pangola and (b) kikuyu grasses. Results to date indicate that in both mixtures, the percentage legume is not greatly reduced under a 5-week interval, but that yields are much lower than those obtained under a 10-week cutting interval. Height of cut in the range 2"-5" had little influence on yields. Fertilization of the mixtures with nitrogen at 365 lbs. per acre per year reduced the percentage legume to very low levels, especially in the 5-week treatments. Similar plots grazed by animals showed that the mixtures were well utilized after 10-weeks regrowth while the pure grasses were unpalatable at this stage, even when fertilized with nitrogen.

A large collection of D. intortum ecotypes has also been evaluated by Dr. P. P. Rotar in several locations. Certain strains were found to be well suited under one set of soil-climate conditions and poorly adapted to others. There is a wide variation with respect to growth habit and the ability to grow vegetatively during the cooler short-day flowering period. Several clones which have been selected for wide area of adaptation, good winter productivity, and habit of growth conducive to persistence under grazing are presently being used to produce a synthetic variety in cooperation with the SCS. Further testing of the synthetic plus selected individual strains under grazing is scheduled for the near future.

The station has tested in one way or another a number of other tropical legumes, including Leucaena leucocephala, Spanish clover (Desmodium sandwicense), stylo (Stylosanthes guyanensis), siratro (Phaseolus purpureus), centro (Centrosema pubescens), lotononis (L. banesii), several varieties of Glycine javanica, Desmodium uncinatum and a number of others. Of these, the most promising appear to be G. javanica, stylo and siratro.

Leucaena leucocephala is also a valuable component of pastures in dry areas having a deep rooting zone. Work underway by Dr. J. L. Brewbaker is aimed at developing a L. leucocephala variety with low mimosine but a high yield of leafy forage.

Legume establishment, both in grass pastures and during renovation operations, has been studied for a number of pasture situations. A brush and fern-covered gulch at 600' elevation characterized by 90" rainfall and an Aluminous Ferruginous Latosol was cleared and seeded to green panic grass and the legumes stylo, centro, G. javanica, intortum and siratro at a cost of \$100 per acre (estimated cost to rancher: \$80) (2). This was accomplished by means of two aerial applications of 4 lbs. silvex per acre eight months apart. This was followed four months later by burning. The seeds were then pelleted and sown by airplane together with treble superphosphate. A second application of fertilizer was made two months later. Excellent establishment was obtained except on the more droughty slopes. Stylo and intortum established better than the other legumes and formed a good mixture with green panic. Subsequent gains by long-yearling Charolais steers indicated that this formerly useless area was capable of yielding about 200 lbs. LWI per acre per year. Further study is in progress to determine the reinvasion (if any) of undesirable species under grazing.

The second approach to legume establishment has been that of "sod-seeding" into established grass swards. The technique presently involves applying fertilizer, pelleted seed, and a spray containing an insecticide, an herbicide, and in some cases trace elements, in a single pass. The spray is applied to a 12-inch band centered on the row. The insecticide is required in order to control cutworms; DDT has proven most satisfactory so far. An application of 1-2 quarts of paraquat per acre of sprayed area controls grass growth during seedling establishment.

Stands have been achieved in some cases by dropping the seed on moist sod in front of a narrow heavily-loaded press wheel. This allows easier operation over rocky ground but has given variable results. Close grazing before seeding and moist conditions after seeding appear to be essential to success with this method.

It is apparent that further work is needed in nearly all aspects of tropical legume research in Hawaii. However, these plants are already making a significant contribution to our beef industry, and the groundwork has been laid for an even greater contribution in the future. We are especially anxious to improve our knowledge of legume fertility requirements on impoverished soils and their management under grazing, and to develop methods of establishment suitable for varying conditions of soil, climate, and existing vegetation.

Literature Cited

1. Hosaka, E. Y. 1945. Kaimi Spanish clover for humid lowland pastures of Hawaii. Haw. Agr. Exp. Sta. Circ. 22.
2. Motooka, P. S., D. L. Plucknett, D. F. Saiki, and O. R. Younge. 1967. Pasture establishment in tropical brushlands by aerial herbicide and seeding treatments on Kauai. Haw. Agr. Exp. Sta. Tech. Prog. Rep. 165.
3. Whitney, A. S. and R. E. Green. 1969. Legume contributions to yields and compositions of Desmodium spp.-pangolagrass mixtures. Agronomy J. (in press).
4. Whitney, A. S., Y. Kanehiro, and G. D. Sherman. 1967. Nitrogen relationships of three tropical forage legumes in pure stands and in grass mixtures. Agronomy J. 59:47-50.
5. Younge, O. R. and D. L. Plucknett. 1965. Beef production with heavy phosphorous fertilization in infertile wetlands of Hawaii. Proc. IX Int. Grassld. Cong. 959-963.
6. Younge, O. R., D. L. Plucknett and P. P. Rotar. 1964. Culture and yield performance of Desmodium intortum and D. canum in Hawaii. Haw. Agr. Exp. Sta. Tech. Bull. 59.

Table 1. Sales of beef steers and heifers for slaughter in Hawaii.

	Feedlot		Range	
	Thousands Sold	Dressed Price	Thousands Sold	Dressed Price
1963 (Ave.)	13.7	42.0	32.0	35.2
1967 (Ave.)	27.4	42.6	27.8	34.4
1969 (March)	----	48.5	----	36.9

Source: Hawaii Crop and Livestock Reporting Service.

Table 2. Performance of Kaimi mixtures
600' elevation, 75" rainfall.

Grass	D.M. Yield	% Legume	C.P. Yield	LWI/hd/day	LWI/A/yr
Pangola	9,500	32	1000	1.63	720
Kikuyu	11,500	44	1450	1.74	575

1. Humic Ferruginous Latosol, pH 4.6. Normal yields are 10-20 lbs. LWI/A/yr.
2. Limed to pH 6.0. Fertilized with N35, P65, K130, B5 and Mo2.
3. Condensed from Haw. Agr. Exp. Sta. Tech. Bull. 59 (6).

Table 3. Performance of D. intortum - Pangola at 1000' elevation, 100" rainfall during second year production.

Treatment	D.M. Yield	% Legume	LWI/hd/day	LWI/A/yr
Lime only*	7,200	29	.34	94
Fertilizer only**	15,500	35	1.53	670
Lime + fertilizer	18,600	32	1.41	740

1. Condensed from Haw. Agr. Exp. Sta. Tech. Bull. 59 (6).
2. Humic Ferruginous Latosol, pH 5.0. Normally yields 10-20 lbs. LWI/A/yr.

* Limed to over pH 5.5. ** N44, P84, K104, B3.5 and Mo2.5

Table 4. Performance of kaimi - pangola and intortum - pangola mixtures at 2100' elevation and 75" rainfall.

Treatment	D.M. Yield	C.P. Yield
Pure Pangola (No nitrogen)	3,780	260
Pangola/Kaimi (Uninoculated)	6,650	760
Pangola/Kaimi (Inoculated)	7,520	865
Pangola/Intortum (Wide rows)	10,820	1,600
Pangola/Intortum (Narrow)	11,970	1,930
Pure Intortum	10,640	2,080

1. Humic Ferruginous Latosol, pH 5.5 and 6.0.
2. Condensed from Whitney and Green (3).

POTENTIAL FOR IMPROVEMENT OF TROPICAL GRASSES -- A Temperate Viewpoint

David H. Timothy

North Carolina Agricultural Experiment Station

An appealing theme for a discussion of this sort is that while many tropical genera and species appear to have great potential, we know little about them. Superficially, at least, there are many desirable attributes scattered among many species of a number of tropical genera which would be potentially useful for the southeastern United States if properly put together by breeding.

Insofar as the grasses are concerned, we have a temperate orientation, arrived at by and large through our heritage, training, and education. The majority of early immigrants to the Southeast was of European stock. The agricultural system, from colonial times until very recently, was based primarily on row crops. The settlers and landowners of the Southeast had no similar experience to those of the Northeast, whose people not only brought many of their grasses with them, but their heritage and farming system as well. Additional grasses which the Northeast settlers introduced were not far removed from their fatherland, and generally were suitable for the farming system and climate in the new land.

All of the grasses used east of the Mississippi River have been introduced -- most of them before 1900, and many of these introductions were represented by only a few grams of seed, e.g., Sudangrass. In the past, what apparently happened is that sporadic or shotgun introductions of grasses were brought in. Some of these were reasonably successful and gave sufficiently suitable results to temporarily relieve the pressure for additional introductions.

When these factors and others are considered, it can be argued that a good portion of the problem concerned with Southeastern grassland agriculture is that collection and exploration for grasses has not been as concentrated or systematic as for other areas. Some may dispute this, but there is only one Regional Plant Introduction Station in the entire Southern region, at Experiment, Georgia. The others are located in Washington, Iowa, and New York. There is not one Regional location where a collection of perennial tropical grasses can be maintained in the vegetative condition within the confines of this country, regardless of how valuable or how great their potential for future grassland enterprises in the South.

Increased interest in southern beef has stimulated additional research on forages. In addition, conditions today are very different from those of a few short years ago. Our agricultural system is now using more machine harvest, storing and feeding methods. We are not completely dependent upon grazing and cheap nitrogen has lessened the requirements for a legume compatible to grass management.

A few years ago I planted a number of tropical and sub-tropical grasses in North Carolina to obtain some idea of what their potential might be in terms of dry matter production. Genera included Andropogon, Bothriochloa, Cynodon, Panicum, Pennisetum, and others. A good many of the entries were killed outright by frost and an additional number succumbed during the winter. The most promising in terms of dry matter appeared to be Pennisetum flaccidum, P. orientale and the bottomland forms of Panicum virgatum. Although these species will not now compete with corn silage, they indicate that appreciable potential exists in several neglected species. This potential should be exploited in generic terms rather than be limited by an intra-specific approach so common to many of the highly cultivated food and forage crops.

An interesting observation along these lines is that notable success in improving forage yield within a species is rare. Exceptional genera include Sorghum and Pennisetum. Both genera contain species used as a cultivated cereal and it appears that success with these genera, as forages, has taken advantage of germplasm from a cultivated crop.

The seed-sown cultivated cereals may sometimes be seen as escapes in weed patches and disturbed sites for a few seasons, but they cannot persist outside the artificial environment that man has created for them and for which they have been selected and bred. They cannot persist without man's aid even in the areas where the crop has supposedly originated. From this, domesticity might be expressed as the inability to escape cultivation and form a part of the vegetative succession. It follows that the number of life cycles that a crop is associated with man is related to domesticity. On the other hand, the forage grasses escape to adjacent sites, subsequently disperse to wider areas, and establish themselves as an integral part of the natural system. They persist in favorable niches in one or more of the vegetational levels of succession. Examples of this in the United States are Kentucky bluegrass, Poa sp.; orchardgrass, Dactylis; tall fescuegrass, Festuca; Johnsongrass, Sorghum; bermudagrass, Cynodon; and in South America, Kikuyugrass, Pennisetum; and guineagrass, Panicum. Some of these introduced grasses have become so successful and ubiquitous as to be declared noxious weeds. However, cultigens of these same species form a major part of the beef and dairy industries in many of those same areas.

In any given locality, ecotypes which best conform to local conditions have been selected for years or centuries. The ecology of such natural ecotypes is entirely different from that of a cultivated monoculture of a food plant. Yet while most of the pasture grasses have not been completely domesticated, we attempt to impose upon them a set of biological conditions which have been used in growing our highly domesticated and cultivated food plants. In spite of this, a few highly productive grasses do well as cultigens. A common feature of these grasses is that there has been a mechanism for escaping from the wild condition. Some are closely related to cultivated cereals and there is evidence of gene exchange between the forage grass and the domesticated food plant. Others have escaped through asexual propagation. Further, the cultivation process alters the genetic composition of the population and its environment, and the plants are not as dependent as formerly upon natural conditions for

growth and survival. By using such grasses, we take advantage of ecological and physiological processes which favor intensive monoculture and man's needs -- not necessarily those which favor species perpetuation.

The use of intensely managed pastures is a relatively new innovation of man, and has been going on for only a few hundreds of years. In this regard, the advances made with the grasses of temperate climates have been notable. Many of the Bromus, Dactylis, Festuca, Phleum, Poa, have been developed under the rigors of intensive agriculture, notable in Europe. Intensive grassland agriculture in tropical or sub-tropical areas has been non-existent until the last 50 to 100 years. We should not be so naive as to conclude that we have been as efficient in a century or so of selecting, domesticating, and improving wild grasses as our forebears, who, since man began, have selected, domesticated and improved our food crops.

The grasses are ubiquitous. In addition to their dominance in prairies and pampas where they make up 99.5% of the ground cover, they may constitute less than 0.5% of the cover in tropical forests where a break in the canopy has occurred. Of perhaps 10,000 grass species, only about 40 are used on an important scale as cultivated pasture grasses. These are widely used outside their limits of natural distribution. Many of the grasses comprising the grasslands of the world have not been successful domesticates. They have evolved along with grazing animals. Their environment, at least when compared to cultivated grasses, is relatively stable. The most successful grasses as domesticates are those occurring in and around forest margins and woodlands. These areas are often disturbed sites -- caused by flooding and washing, fire, uprooted trees, etc. -- and can be considered as floristic and ecological transition zones. The grasses which form a part of this sub-climax are opportunistic and aggressive, a highly desirable trait for any pasture grass.

For the past several years I have been collecting and working with Tripsacum, a genus related to maize and which can be hybridized with it. Several of the above points can be illustrated by a brief look at Tripsacum. All the nine described species are perennial. One species, T. laxum or Guatemalagrass, is cultivated for green chop or silage. It is a highly sterile polyploid propagated by cuttings and has yielded over 60 tons of dry matter/ha/yr in Colombia. The other 8 species are wild and most are relished by cattle when accessible. The genus contains endemic as well as cosmopolitan species, several levels of polyploidy, various types of isolating barriers, extreme morphological variation, and, in some cases, apomixis. The geographical range of the genus is from Connecticut and Iowa south as far as northern Paraguay; from the Atlantic coast into Texas and Oklahoma in North America; in South America, its east-west distribution spans the continent. The habitat varies from cracks and crevices in rock or lava formation to deep alluvial soils, and from arid zones to areas having over 300 inches of annual rainfall. I have never found Tripsacum on a stable site. Invariably it has been found on a disturbed site or an ecological transition zone, e.g., dry sandy streambeds subjected to seasonal flooding in thorn scrub of Eastern Bolivia; margins of

wooded tracts in the Pampa-Isla region of the Beni River Basin in Western Bolivia; on river banks in the Peruvian Selva; along road cuts, streams and rivers in Colombia and Venezuela; on cliff ledges, in crevices of escarpments, and on talus along the Eastern Cordilla and into the margins of the Llanos of Colombia and Venezuela. Additional requirements were related to soil moisture and good drainage, although the habitat was not restricted to specific soil types or vegetative associations. However, other aggressive grasses of a weedy nature commonly found in association and competing with Tripsacum included several species of Paspalum, Hyparrhenia, Panicum, Melinis, etc. Although I am not as familiar with these, some might serve as additional examples.

The tropical grasses are not usually conceded to have the nutritive qualities deemed necessary by most temperate animal men. It is hoped and anticipated that quality can be improved. Until then it should be remembered that excellent animal performance has been obtained with tropical grasses in well designed and well executed experiments. What must be remembered is that the grass, animal, and management system which is indicated for a particular zone in Brazil, for example, is not necessarily that which should be used in Bolivia, or Colombia, or Puerto Rico, and vice versa.

GRASS IMPROVEMENT IN THE TROPICS

S. C. Schank
University of Florida

Are the tropics and tropical grasslands really important? Demographers have estimated that by the turn of the century there will be approximately 7 1/2 billion persons living in the world, and 6 billion of these will reside in the tropics. The tropics are usually defined as the lands between 30° N and 30° S latitude, and constitute about 40% of the land area of the world. (Hutton, 1968).

The definition of grass improvement is not so easily made. Improvements come from many sources and I would like to emphasize that the genetic factors of improvement interrelate with those of management, physiology and pathology, to upgrade yield and quality. Grass breeding is therefore not synonymous with grass improvement because the latter term should include the comprehensive interactions between the plant breeder and other disciplines.

An outline of the most important relationships -- as a plant breeder sees them -- for improving grass production in the tropics would include:

1. Introduction of plants and capitalizing on natural genetic variation.
2. Management and soil fertility.
3. Botanical information such as floral structure, details of mode of reproduction, seed set, seed germination, taxonomy and morphology to aid hybridization and selection.
4. Plant physiological differences between tropical and temperate species including photosynthesis, photoperiodic responses, lack of photo-respiration and other factors affecting yield or plant growth.
5. Statistics to aid selection and evaluation.
6. Recognition of diseases and insects and initiation of breeding programs to incorporate inherent resistance.
7. Chemical and biochemical tests for quality, elimination of toxicity.
8. Animal performance and economics of production.

Now I will attempt to illustrate why the plant breeder needs the help and cooperation from these other disciplines. In the past decade, each scientific discipline has literally been flooded with information. This has tended to segregate the scientists into little groups that speak a common technical language. We have seen this development take place within our own forage technical committees that meet prior to the Southern Forage Crop Improvement Conference. Discussions in one group may center around the intake or cell wall constituents. Another committee may be delving into problems of photorespiration or microclimates affecting photosynthetic rate, while the breeders are talking about apomixis, incompatibilities, or ploidy level. I think it is indeed fortunate that we have an opportunity in this general session to examine

the overall problems of management, ecological environments, and genotypes. It will not be possible to cover all the interactions between the scientists and their disciplines, but rather I have chosen several from this list of eight to show how progress can be much more rapid with this mutual understanding. Slides will present salient points on these relationships.

Introduction of plants

"The greatest service which can be rendered to any country" (as Thomas Jefferson wrote in 1790) "is to add a useful plant to its culture." An example of a highly successful forage grass which was fortuitously introduced into Florida is pangolagrass. The story of pangolagrass is well documented and it can generally be stated that the 250,000 acres of pangolagrass pasture in Florida and the millions of hectares of pangolagrass in Central and South America arose from an introduction made in the mid 1930's. The Florida station will officially release in the summer of 1969 a new cultivar named slenderstem digitgrass (McCaleb & Hodges, 1969). Studies on this introduction at the Range Cattle Experiment Station, Ona, by McCaleb and Hodges indicate that slenderstem digitgrass has a different seasonal distribution of yield than pangola. This new cultivar should be tested in other tropical areas.

The Oakes collection (1965) of Digitarias from Africa is an excellent example of how quickly plant introductions can be established in numerous locations, even if the plants are predominately vegetatively propagated. Three locations were chosen to receive the new forage grass introductions from Oakes after they had passed through plant quarantine, namely Experiment, Georgia; Gainesville, Florida; and Rio Piedras, Puerto Rico. Although less than five years has elapsed, sizeable numbers of these new introductions have been redistributed and observed in Surinam, Guyana, Brazil, Trinidad, Jamaica, Venezuela, and other Latin American locations.

Nearly every forage station has grass and legume introduction plots. Because of their neat boundaries, small plot size, and white stakes, these introduction gardens have been nicknamed 'cemetery plots'. Unfortunately, this is exactly the fate of many new grasses -- they enter the plot, and although they persist well, and many even show outstanding vigor, they are in actuality 'dead' as long as they remain in these plots. Just think how unfortunate it would have been if pangolagrass had remained in the Florida garden of introductions without release.

Management and fertility

Replicated plots are one of the best ways to study management regimes on any given species. Yield data from such replicated plots may be obtained by some of the new flail type harvestors recently reported in the literature. (Allen, Castleman, & Thomas, 1968; Collins, Rykerd, & Noller, 1969).

Fertilizer recommendations are another closely related aspect of tropical

grassland management. Blue (1969) studied fertilization of pangolagrass in British Honduras and found that pangolagrass forage yields were increased 13 fold by adding phosphorus when other nutrients were applied in substantial quantities. The response to lime on these same virgin soils of British Honduras was linear. Responses to N fertilization have been equally striking, with 0, 200, 400, 800, and 1,600 pounds of nitrogen applied per acre yearly in intensively managed pastures of Puerto Rico. (Vicente-Chandler, J. et. al. 1964). These workers found yields of guinea, pangola and paragrasses increased sharply with N levels up to 400 pounds but rose less rapidly up to the 800-pound rate. Production of napiergrass climbed steadily with rates up to 800 pounds per acre yearly, but molasses grass did not respond to N above 200 pounds per acre. In Columbia, (Crowder, 1967, and Crowder et. al. 1964) recommended that the quantity of applied N can be reduced under grazing. His grazing trials with para and pangolagrasses in Columbia showed that a 35-50 pound per acre topdressing at six to eight week intervals was sufficient under a rotational grazing system.

The plant breeder becomes vitally interested in fertility rates, and must do his testing under several fertility levels. For example, the new IR 5 rice variety which has been bred by the International Rice Research Group in the Philippines has little advantage, under low fertilization, but under high fertilization much higher yields are obtained. The morphology and phenotype of the plant has been changed sufficiently to take advantage of more sunlight, and to provide a stronger stem to support the inflorescence. (Anonymous, 1968).

Botanical information

Plant breeders have always been interested in the mode and manner of reproduction of their species. Details such as megasporogenesis, microsporogenesis, embryo sac development, anomixis, and incompatibilities are vital.

Simpson & Bashaw (1969) recently presented additional evidence on cytology and reproductive characteristics in Pennisetum setaceum, fountaingrass. Before launching an extensive breeding program, a feasibility study was made by Simpson & Bashaw to determine if cold tolerance, uniformity and fertility could be improved in P. setaceum. Their conclusion was that apomixis was present and because of the lack of sexuality, very little improvement could be made.

It becomes rather embarrassing for a plant breeder to work a large number of years, only to discover that the species on which he has been working is an obligate apomict, and does not reproduce by sexual means. Warmke (1954) showed that in Panicum maximum, seedling progenies in experimental plantings were found to be extremely uniform; and open-pollinated seed collected from plants of five varieties intermixed failed to yield recognizable hybrids. These peculiarities strongly suggested the occurrence of apomixis, which he verified cytologically.

Plant physiological differences

Tropical grasses can fix carbon dioxide at a rate almost twice that of temperate species (El -Sharakawy et. al. 1967). Other interesting studies comparing tropical and temperate species have also recently been made by Downes and Hesketh 1968, and Downton et. al. 1969. By cooperative research between the plant breeder and physiologist more productive plants can be developed. Instrumentation to detect changes in photosynthetic rate (and therefore yield potential) have been developed recently (Wolf et. al. 1969) (West et. al. 1968). Since these photosynthetic measurements are made on intact leaves, the leaf is quickly placed inside an open port in a gas-exchange chamber. Air of known CO₂ content is pumped into the system with enough excess to provide an air seal at the leaf port. This means the leaf is sealed into the chamber by positive air pressure, and once equilibrium is established, direct measurements are made of net carbon exchange. Wolf and co-workers at Beltsville made over 20 such measurements in 1 hour on potted plants in a growth chamber. Because of the rapidity of measurement, this versatile method can be applied to breeding studies which require evaluation of a large number of plants.

Plant physiologists have also studied growth in a gradient of temperatures, by means of an aluminum gradient bar (West et. al. 1968). Growth rates of plants in pots or in nutrient solution can be made over a wide range of temperatures. Techniques such as this would provide a rapid method for screening plant materials for growth potential in low temperatures.

Dr. Rex Smith at the University of Florida has been using gel electrophoresis to study and characterize some of the Digitaria introductions and hybrids. The leaf extract is prepared and placed on the top of an acrylamide gel in the plexiglass chamber with current applied. The various peroxidase isoenzymes move at different rates, and after staining, each introduction has a characteristic complement of enzyme bands. Using such techniques it may be possible to "fingerprint" or characterize an introduction or species at the enzyme level.

Brown and Allard (1969) state that electrophoretic techniques which permit mass screening for enzyme mutants are increasingly being recognized as powerful tools in population genetics. Although these techniques are basic or pioneering research, we must recognize their applicability in forage breeding and work closely with the plant physiologists in the future.

Statistics to aid selection and evaluation

The implication and use of statistics in plant breeding are many and complex. Whole books and symposia have been written on this subject (Frey, 1966). I will not attempt to cover this topic, or give examples, but simply refer you to others who have expertise in this field.

Diseases and insects

Recognition of diseases and insects and initiation of breeding programs

to incorporate inherent resistance has been a mainstay of crop improvement for decades. Entomologists, plant pathologists, and virologists can be a tremendous asset to the plant breeder particularly with tropical grasses. For example, the search for insect vectors, and the identification of the scale insect (Antonia graminis) has led to some new applications of biological principles. A tiny wasp which parasitizes the scale insect can successfully eliminate this problem. (Dean et. al. 1961).

An unanswered question, however, is how to control the devastating disease of pangolagrass known as pangola stunt virus. Yields are tremendously reduced, and the syndrome of effects include twisted leaves, dieback of the tips, discoloration of the leaves, and shortened internodes. Since pangolagrass is propagated vegetatively and does not produce seed, all "pangolagrass" is of the same genotype. Therefore, all pangolagrass (Digitaria decumbens Stent) would uniformly be susceptible to this malady. For this reason a breeding program at the University of Florida was initiated and an F₂ population is currently being screened in Guyana. (Schank, 1968).

Chemical and biochemical tests

Chemical and biochemical tests for quality which affect intake continue to be a major goal of both the animal scientists and the forage plant scientist. Last year's report of this conference contained three excellent papers on forage quality by Buckner, Burton, and Moore. Moore emphasized that basic information is needed on the physical and chemical properties of forage which may influence the palatability and the selectivity of forage by animals. Apparatus to measure cell wall components has been developed with the fibrous residue representing the cell walls or ADF. Lignin and silica measurements are of prime importance because of an inhibitory effect of lignin and silica on cell wall digestion (van Soest and Wine, 1967).

In cooperation with Dr. P. J. van Soest, six tropical forage grasses from our experimental plots in Florida were chosen and analyzed at 3 stages of maturity (Table 1). Van Soest's predictive equation on estimated digestibility gave ranges from 78% digestibility on 14-day-old Digitaria swazilandensis down to 57% on 42-day-old digitgrass 525. A recent paper by Deinum, Van Es and Van Soest (1968) points out that further improvement of the summative equation is underway.

The rapid protein test of MacKenzie and Perrier (1969) may provide a simple chemical test which can not only test thousands of introductions for quality but also the thousands of hybrids which are generated in the breeding program. Again, I emphasize that this is an area in which the plant breeder needs help and cooperation.

Animal performance

Finally, the plant breeder reaches the point of seeing how well his product passes animal performance. Dr. Mott has already covered this aspect in his talk in this symposium. I simply would like to show some photographs

of forage and cattle taken in various locations in the tropics to illustrate the importance of having both good grass and cattle, and mention Morley and Spedding's excellent paper (1968) on agricultural systems and grazing experiments.

In conclusion, I want to emphasize again that tropical grass improvement is based upon very broad concepts in which many disciplines are needed to answer the problems. I personally am grateful for the opportunity SPFCIC gives each of us to converse with other scientists both within and outside of our special areas of interest. Grass improvement in the tropics is therefore a team effort, and I hope our team can meet the challenges ahead.

References Cited

- Anonymous. 1968. IR5 - a new high-yielding variety. IRRI Reporter 4:1-4.
- Allen, R. J., Jr., T. W. Castleman, and F. H. Thomas. 1968. An improved forage harvester for experimental plots. Agron. J. 60:584-585.
- Blue, W. G. 1969. Fertilizer response with pangolagrass on Puletan loamy fine sand, British Honduras, as indicated by pot experiments. Trop. Agric. 46:25-29.
- Brown, A. H. D. and R. W. Allard. 1969. Inheritance of isozyme differences among the inbred parents of a reciprocal recurrent selection population of maize. Crop Sci. 9:72-75.
- Buckner, R. C. 1968. Inheritance of forage quality. Mimeo Report. Twenty-fifth Southern Pasture Forage Crop Imp. Conf. 25:8-9.
- Burton, G. W. 1968. What information does the forage crop scientist need from the animal scientist? Mimeo Report. Twenty-fifth Southern Pasture Forage Crop Imp. Conf. 25:9-10.
- Collins, K. L., C. L. Rykerd, and C. H. Noller. 1969. A self-propelled experimental plot forage harvester. Agron. J. 61:338-339.
- Crowder, L. V., A. Michelin, A. Bastidas. 1964. The response of pangolagrass (Digitaria decumbens Stent.) to rate and time of nitrogen application in Colombia. Trop. Agr. 41:21-29.
- Crowder, L. V. 1967. Grasslands of Colombia, (a review article). Herbage Abstr. 37:237-245.
- Dean, H. A., M. F. Schuster, and J. C. Bailey. 1961. The introduction and establishment of Dusmetia sangwani on Antonina graminis in south Texas. J. Econ. Entom. 54:952-954.

- Deinum, B., A. J. H. van Es, and P. J. van Soest. 1968. Climate, nitrogen, and grass. II. The influence of light intensity, temperature and nitrogen on vivo digestibility of grass and the prediction of these effects from some chemical procedures. *Neth. J. Agric. Sci.* 16:217-223.
- Downes, R. W. and J. D. Hesketh. 1968. Enhanced photosynthesis at low oxygen concentrations: differential response of temperature and tropical grasses. *Planta* 78:79-84.
- Downton, J., J. Berry, and E. B. Tregunna. 1969. Photosynthesis: temperate and tropical characteristics within a single grass genus. *Science* 163:78-79.
- El-Sharakawy, M. A., R. S. Loomis, and W. A. Williams. 1967. Apparent reassimilation of respiratory carbon dioxide by different plant species. *Physiol. Plant* 20:171-186.
- Frey, K. J. Ed. 1966. *Plant Breeding Symposium*. Iowa State Univ. Press. 430 p.
- Hutton, E. M. 1968. Tropical and sub-tropical grassland research. *Agric. Sci. Rev.* 6:7-17.
- McCaleb, J. E. and E. M. Hodges. 1969. Slenderstem digitgrass. *Univ. Fla. Exp. Sta. Circ.* S-201.
- MacKenzie, J. and E. R. Perrier. 1969. Colorimetric determination of protein in feed and forage crops. *Agron. J.* 61:332.
- Moore, J. E. 1968. What information does the animal scientist need from the forage plant scientist? Mimeo Report. Twenty-fifth Southern Pasture Forage Crop Imp. Conf. 25:10-27.
- Morley, F. H. W. and C. R. W. Spedding. 1968. Agricultural systems and grazing experiments, (a review article). *Herbage Abstr.* 38:279-287.
- Oakes, A. J. 1965. Digitaria collection in South Africa. *Trop. Agr.* 42:323-331.
- Schank, S. C. 1968. Breeding grasses for resistance to pangolagrass stunt virus. *Sunshine State Agric. Res. Report* 13:5-7.
- Simpson, C. E. and E. C. Bashaw. 1969. Cytology and reproductive characteristics in Pennisetum setaceum. *Amer. J. Bot.* 56:31-36.
- van Soest, P. J. and R. H. Wine. 1968. The determination of lignin and cellulose in acid-detergent fibre with permanganate. *J. Assoc. Off. Anal. Chem.* 51:780-785.
- Vicente-Chandler, J., R. Caro-Costas, R. W. Pearson, F. Abruña, J. Figarella, and S. Silva. 1964. The intensive management of tropical forages in Puerto Rico. *Bull.* 187, Univ. of Puerto Rico.

- Warmke, H. E. 1954. Apomixis in Panicum maximum. Amer. J. Bot. 41:5-11.
- West, S. H., R. H. Biggs, and J. M. Baskin. 1968. Growth and photosynthesis of pangolagrass in a gradient of temperatures. Soil Crop Sci. Soc. Fla. 28: In Press .
- Wolf, D. D., R. B. Pearce, G. E. Carlson, and D. R. Lee. 1969. Measuring photosynthesis of attached leaves with air sealed chambers. Crop Sci. 9:24-27.

Table 1. Chemical analyses from 6 sub-tropical grasses harvested at three different stages of maturity at Gainesville, Florida. Analyzed by Dr. P. J. Soest.

Maturity*	USDA Pl. No.	Field Identification	CWC NDF	ADF	Lignin KMnO ₄	Cell- ulose	ADF Ash Silica	Est.** Dig.
1	318669	<u>Entolasia imbricata</u> (Bungomagrass)	53.72	34.70	3.39	28.81	2.46	70
2	"	" " "	54.48	34.76	4.48	28.36	1.93	66
3	"	" " "	70.16	46.8	5.89	39.96	1.96	60
1	299892	<u>Digitaria sp.</u> (Digitgrass 525)	57.83	35.11	3.21	30.76	1.14	75
2	"	" " "	66.31	42.08	5.72	35.16	1.20	64
3	"	" " "	69.85	42.28	7.27	34.11	.91	57
1	299837	<u>D. swazilandensis</u> (Digitgrass 594)	61.55	36.88	2.73	33.47	.68	78
2	"	" " "	61.83	35.57	2.89	31.47	1.20	75
3	"	" " "	65.62	37.66	4.97	31.48	1.22	65
1	299995	<u>Hemarthria altissima</u> (UF 554)	63.77	32.12	3.18	28.11	.84	74
2	"	" " "	58.96	31.46	3.43	26.71	1.33	71
3	"	" " "	72.56	31.73	4.55	26.51	.68	61
1	299870	<u>Digitaria valida</u> (Digitgrass 539)	58.02	36.83	2.45	33.37	1.00	77
2	"	" " "	68.47	43.30	4.81	37.12	1.37	69
3	"	" " "	71.46	46.62	6.04	38.91	1.66	62
1	111110	<u>Digitaria decumbens</u> (Pangolagrass)	60.60	37.03	4.34	31.42	1.27	69
2	"	" " "	63.08	39.15	5.27	33.19	.70	66
3	"	" " "	67.48	40.61	6.70	33.06	.85	59

* Maturity stages are as follows:

1. 14-19 days regrowth after initial cutting.
2. 30-35 days original growth (harvested as initial cut).
3. 42-57 days regrowth after initial cutting.

** Estimated from summative equation derived by Van Soest. Metabolic constant of 12.9 used throughout.

SPFCIC General Business Meeting, Wednesday May 7, 1969

The general business meeting of SPFCIC was called to order at 4:45 P.M. on May 7, 1969, by Chairman M. E. Riewe. He announced that receipts for personal expenses such as registration fee, tours, banquet, and lunches were now available at the registration desk.

J. E. Moore presented the following report:

Report of the committee to propose an organizational vehicle to do forage quality tests on a regional basis for research purposes.

The committee met on February 3, 1969, at Mobile, Alabama. As a result of this meeting, the committee wishes to make the following statement to the SPFCIC:

1. A regional forage testing laboratory does not appear to be desirable at this time. Further, the funds that would be required for such a program can be expended in more immediately productive ways within each of the Southern States.
2. Each of the presently available laboratory techniques for forage testing has limitations which discourage its widespread adoption as a "standard" method. This is especially true when more than one type of forage is involved and when prediction of voluntary intake is desired.
3. The present literature suggests, however, that a two-stage in vitro fermentation and digestion technique (Tilley and Terry) can be successfully used for screening large numbers of samples. The equipment and supplies needed for this technique are modest. The possibility still exists, however, that a forage with an improved voluntary intake will not be detected using this particular in vitro technique.
4. Further research is urgently needed relating the in vivo values of voluntary intake and nutrient digestibility to various characteristics of forages which may be determined in the laboratory. This research should be conducted at as many locations as possible, and with each forage important in the South. Only through such research can the method, or combinations of methods, be determined which will assist forage production researchers to estimate forage nutritive value when only small samples are available. Cooperative regional or sub-regional efforts in this direction are needed. Those stations having an ongoing laboratory evaluation program might consider

analyzing forage samples from intake and digestion trials conducted at other stations. The S-45 Technical Committee would seem to be an ideal nucleus for such cooperative efforts. However, other forage evaluation researchers in the South who are not members of S-45 should also be included.

Finally, in response to the specific charge to the committee "to propose an organization vehicle", the committee wishes to make the following recommendation and have it placed in the form of a motion before the SPFCIC, as follows:

The Executive Committee of the SPFCIC appoint a standing committee, having the title of "Forage Evaluation Committee", with the following responsibilities:

1. Present an annual report to the SPFCIC summarizing the latest research on forage evaluation methodology and recommending techniques for use in forage quality testing for research purposes.
2. Stimulate cooperative research on forage evaluation methodology in the South by establishing lines of communication between those researchers concerned with this problem.

Respectfully submitted,

R. C. Buckner	H. D. Ellzey
J. C. Burns	C. S. Hoveland
G. W. Burton	J. E. Moore (Chairman)

The motion to accept the Report carried unanimously. A motion by Moore that S-45 Technical Committee or its successor serve as the nucleus (ad hoc committee) for the Forage Evaluation Committee recommended within the Report carried unanimously. Riewe explained that revision or termination of S-45 is due July 1970 and that, if unfunded, the group probably will continue as a Work Group.

Chairman Riewe read a letter from Dean Henry W. Garren of University of Georgia, dated 4 March 1969, extending an invitation to SPFCIC to visit Georgia in 1970. A motion to accept the invitation carried unanimously. Time of meeting was discussed; International Grassland Congress in Australia in April 1970 was noted. Date and place of meeting will be announced at a later date by Georgia.

Report of Nomination Committee by D. S. Chamblee nominated Dr. J. Velez-Fortunio, Head, Department of Plant Breeding, University of Puerto Rico, as Chairman Elect-Elect of SPFCIC; the motion to close nomination and to elect Dr. Velez-Fortunio by acclamation carried unanimously.

The Chairmen (or their designated representative) and Past Chairmen of Interest Groups (1 vote per group) and officers of SPFCIC, all constituting the Executive Committee of SPFCIC, for the forthcoming year are as follows:

<u>Group</u>	<u>Admin. Adv.</u>	<u>Past and Program Chairmen</u>	<u>Current Chairmen</u>
S-45	C. E. Barnhart	H. D. Ellzey	J. E. McCroskey
SFBG	O. B. Garrison	R. C. Buckner	J. B. Powell
SFPEWG	A. T. Wallace	E. G. Beinhart, Jr.	C. S. Hoveland
SFEWG		S. H. Dobson	J. D. Burns

SPFCIC	Past-Past Chairman	L. H. Taylor
	Past and Program Chairman	M. E. Riewe
	Chairman	C. L. Mondart, Jr.
	Chairman Elect	D. H. Timothy
	Chairman Elect-Elect	J. Velez-Fortuno
	Permanent Secretary	R. C. Leffel

Dr. Riewe announced that Resolutions Committee Report will be given at banquet tonight. An executive committee meeting probably will be held tomorrow evening immediately upon return from tour.

The meeting was adjourned at 4:55 P.M.

SPFCIC Executive Committee Meeting, Thursday, May 8, 1969

An Executive Committee meeting of SPFCIC began at 4:55 P.M. Thursday, May 8, 1969, with Past Chairman L. H. Taylor presiding; M. E. Riewe had not returned from tour. Also present were C. R. Owen, R. C. Buckner, E. G. Beinhart, Jr., C. M. Taliaferro, C. L. Mondart, Jr., H. D. Ellzey, D. S. Chamblee, and R. C. Leffel.

A discussion on Program for 1970 ensued:

Ellzey advocated a good tour, at expense of papers if necessary. Buckner suggested a visit to the new Utilization Laboratory at Athens, or an introduction of researchers at this Lab to SPFCIC. The status of the Lab was not known to the group assembled, but the consensus was to establish contact with the Lab.

Taylor suggested a one-day program for Work Groups. Beinhart suggested some joint meetings of Work Groups. The consensus was a first-day program of papers for SPFCIC and a second-day (or half-day, at discretion of Host) program of tour(s).

A discussion followed on allocation of time during first day of SPFCIC. At this point, upon suggestion by Group and in Riewe's absence, Chairman Mondart called the meeting to formal order. A motion, by Ellzey and seconded by Chamblee, "that the Host Institution shall constitute the program for first day from the opening of Session to the first break in the morning or any portion thereof, that SPFCIC Program Committee shall constitute the remaining program for the day, and that all or part of the second day shall be devoted to a tour arranged by the Host Institution", passed. At this point, M. E. Riewe, D. H. Timothy, and D. G. Cummins arrived and upon briefing, concurred with the motion. Local Arrangements Committee at Georgia was asked, via Cummins, to contact the new Utilization Laboratory. Cummins advised that Regional Water Laboratory was also at Athens.

A discussion on specific Program followed: Ellzey suggested future role of pastures in a forage feeding program -- beef cattle and dairy cattle. Riewe commented on the lack of provision to discuss pasture programs within S-45. Chamblee urged coordination of Interest Group and SPFCIC Programs. Considerable discussion ensued on planning of programs by both Work Groups and SPFCIC. A plea was made for a common interest program on first day of SPFCIC meeting. Cummins suggested emphasis on forage utilization, including pelleting, for a SPFCIC Program. Riewe suggested recycling of nutrients. Beinhart commented that if future of pastures is considered, an economist be considered. Buckner suggested that an extension worker also be included. Chamblee suggested that one species, such as fescue, could be emphasized; also, fescue and bermudagrass for South; these topics might also be suitable for Work Group Programs. The Committee agreed that bermuda could serve as a Work Group's joint session for one-half day. The role of Work Groups was reiterated; it was agreed that each Program of Work Groups should be submitted to Program Chairman of SPFCIC and that he should coordinate and avoid duplication of Work Group and SPFCIC Programs.

Riewe suggested that in some environments, tours prior to session of papers may be more informative. A discussion on past, current, and future financial provisions of SPFCIC followed. A motion to increase registration fee to \$4.00 (four dollars) passed unanimously.

Riewe suggested that the Report of the Forage Evaluation Committee and subsequent motion by Moore be studied and that the Executive Committee comply appropriately.

The meeting was adjourned at 6:20 P.M.

SPFCIC Executive Committee Meeting, Tuesday, May 6, 1969

Past Chairman L. H. Taylor, Presiding

The Executive Committee meeting of SPFCIC was called to order at 7:45 P.M. Tuesday, May 6, 1969, by Past Chairman, L. H. Taylor. Also present were H. A. Fribourg, C. H. Gordon, D. H. Timothy, S. H. Dobson, D. S. Chamblee, C. R. Owen, R. C. Buckner, H. D. Ellzey, C. L. Mondart, Jr., E. C. Holt (for Riewe), G. L. Spain, E. G. Beinhart, Jr., W. W. Woodhouse, Jr., and R. C. Leffel. L. H. Taylor reported that Chairman Riewe's arrival in San Juan was expected sometime that evening.

Chairman Taylor announced that Reports by Nominations Committee (E. C. Holt, J. E. McCroskey, and D. S. Chamblee, Chairman) and Forage Quality Evaluation Committee (R. C. Buckner, J. C. Burns, G. W. Burton, H. D. Ellzey, C. S. Hoveland, and J. E. Moore, Chairman), were due at the general business meeting of the morrow and that the Resolutions Committee (W. B. Anthony, R. C. Buckner, and D. E. McCloud, Chairman) Report was due the night of the banquet. He also announced that invitations have been received for future meetings of SPFCIC from Georgia (for 1970), South Carolina (1971), and Oklahoma (1971). The visit to Oklahoma may also concern Western Grass Breeders' Conference; Dr. Beinhart indicated that a 1972 visit to South Carolina was possible, should the 1971 meetings be in Oklahoma.

A discussion of publication of Work Groups Reports followed: it was the consensus that such reports should be included within Report of SPFCIC, with identity of each report indicated on the one cover. A separate table of contents, and abstracts or papers, each limited to a maximum of 3 pages, shall constitute each Work Group Report.

In lieu of Anthony's absence, it was suggested that the Resolutions Committee Report at the banquet be given bilingually (Spanish and English) by Henry Fribourg.

The meeting was adjourned at 8:15 P.M.

Señoras, Señoritas y Caballeros,

Es un placer y honor para mí presentarles este reporte del Comité de Resoluciones:

POR TANTO QUE esta Conferencia, la vijesimasexta Conferencia de Pastos del Sur y de Mejoramiento de Plantas Forrajeras, ha sido una de beneficio, inspiración e instrucción inusitada, y por tanto que existió un espíritu de amistad y de intercambio de ideas tremendo, y a demás,

POR TANTO QUE éso fué realizado debido a los esfuerzos hercúlaneos de los que planearon el programa y de los que participaron en aquél;

POR CONSIGUIENTE, SEA RESUELTO QUE esta Conferencia expresa su agradecimiento y su reconocimiento a los oficiales y a todos los participantes en el programa, y especialmente a la Administración, a la Facultad, y a todos los miembros de la Universidad de Puerto Rico y de la Estación Experimental Agrícola, por su amable hospitalidad y por todos los esfuerzos que hicieron para el confort de los delegados, las cortesías que les fueron ofrecidas, las facilidades soberbias y las excursiones instructivas que fueron realizadas y que tanto contribuyeron al éxito de esta Conferencia.

Debe de ser congratulada la Universidad de Puerto Rico por su interés y su soporte de las investigaciones en plantas forrajeras tropicales y por su dirección y sus realizaciones en este campo de investigación.

Extendemos nuestros agradecimientos al Comité de Hospitalidad y Arreglos Locales, bajo la competente dirección del Dr. J. Velez-Fortuño, y especialmente al Dr. J. Vicente-Chandler y la Sra. Vicente, como también a la Señora Socorro-Gaztambide, la Señora Maria Fernandez, la Señora E. Fontanet, la Señora Amyltha T. Santiago, la Señorita V. Gonzalez, la Señorita Dora Matos, el Dr. Gene Spain, el Dr. O. D. Ramirez, el Sr. A. Rodriguez, el Sr. Peter C. Sweere, el Dr. K. G. Shambu, el Sr. J. E. Muriente, el Dr. A. Sotomayor, el Sr. F. Abruna y el Sr. Roy Woodbury. Agradecimientos especiales expresamos al presidente Dr. M. E. Riewe y al secretario permanente Dr. R. C. Leffel, por su dirección efectiva durante el año pasado, y al Dr. Lincoln Taylor quien arregló el programa técnico de la Conferencia.

Proponemos nosotros, el Dr. Mc. Cloud, el Dr. Buckner, y yo, miembros del Comité, que esta resolución sea adoptada y entrada en las minutas de la Conferencia, y que una copia de esta resolución y cartas de agradecimiento sean mandadas al Sr. Salvador Alemany-Planell, Decano de Ciencias Agrícolas, Universidad de Puerto Rico, al Dr. J. Vicente-Chandler, Director de la Estación Experimental Agrícola, Universidad de Puerto Rico, y al Dr. J. Velez-Fortuño, Jefe del Departamento de Genética, Universidad de Puerto Rico.

Henry A. Fribourg

Ladies and Gentlemen,

It is a pleasure and an honor for me to present to you this report of the Resolutions Committee.

WHEREAS, This Twenty-sixth Annual Conference of the Southern Pasture and Forage Crops Improvement Conference has proved to be one of unusual benefit, inspiration and instruction, with a fine spirit of friendliness and understanding prevailing, and,

WHEREAS, This result has been attained by the concerted efforts of those who planned the program and those who participated therein; therefore, be it

RESOLVED, That this Conference express its grateful appreciation to the Officers and all participants in the program, and especially to the Administration and Staff of the University of Puerto Rico for their gracious hospitality and for the provision made for the comfort of our delegates, courteous service, superb facilities and instructive field tours offered which contributed much to the success of this Conference.

The University of Puerto Rico is to be commended for its interest and support of tropical forage crops research and for its leadership and accomplishments in this field of research.

Appreciation is expressed to the Local Arrangements and Hospitality Committee, under the competent chairmanship of Dr. J. Velez-Fortuño, and especially to Dr. and Mrs. J. Vicente-Chandler, as well as to Mrs. Socorro-Gaztambide, Mrs. Maria Fernandez, Mrs. E. Fontanet, Miss Amyltha T. Santiago, Miss V. Gonzalez, Miss Dora Matos, Dr. Gene Spain, Dr. O. D. Ramirez, Mr. Rodriguez, Mr. Peter C. Sweere, Dr. K. G. Shambu, Mr. J. E. Muriente, Dr. A. Sotomayor, Mr. F. Abruna, and Mr. Roy Woodbury. Special thanks are due to the Conference chairman, Dr. M. E. Riewe and to Permanent Secretary Dr. R. C. Leffel, for their effective leadership during the past year, and to Dr. Lincoln Taylor who has served as program chairman.

We move that this resolution be adopted and recorded in the minutes and that a copy of this resolution and letters of appreciation be sent to Mr. Salvador Alemany-Planell, Dean of Agricultural Science, University of Puerto Rico, to Dr. J. Vicente Chandler, Director of the Agricultural Experiment Station, University of Puerto Rico, and to Dr. J. Velez-Fortuño, Head, Plant Breeding Department, University of Puerto Rico.

By Robert Buckner
Henry A. Fribourg
Darnell McCloud, Chairman

1969

LIST OF THE MEMBERS THAT ATTENDED THE SOUTHERN PASTURE AND FORAGE
CROP IMPROVEMENT CONFERENCE, AT RIO PIEDRAS, PUERTO RICO:

- | | |
|-------------------------|-------------------------|
| 1. W. A. Kendall | 26. Vincent N. Schroder |
| 2. C. T. Blake | 27. Stanley C. Schank |
| 3. D. S. Chamblee | 28. Gerald O. Mott |
| 4. Don R. Jacobson | 29. A. S. Whitney |
| 5. John W. Lusk | 30. W. E. Monroe |
| 6. H. D. Ellzey | 31. Jack E. McCroskey |
| 7. G. L. M. Chappell | 32. C. R. Owen |
| 8. C. A. Trevor-Roper | 33. C. L. Mondart Jr. |
| 9. Aree Waranyuwat | 34. F. H. Redman-Cabral |
| 10. Harlan E. White | 35. Robert M. Graig |
| 11. D. E. McCloud | 36. H. L. Chapman |
| 12. Murley, W. Ray | 37. Peter G. Hogg |
| 13. John E. Moore | 38. C. B. Browning |
| 14. M. J. Montgomery | 39. Marvin E. Riewe |
| 15. S. H. West | 40. J. A. Lancaster |
| 16. J. E. McCaleb | 41. R. J. Allen Jr. |
| 17. Rex L. Smith | 42. Joe D. Burns |
| 18. O. Charles Ruelke | 43. Aino V. A. Jacques |
| 19. Lincoln H. Taylor | 44. C. L. Dantzman |
| 20. C. R. Richards | 45. Degras, L. M. |
| 21. W. R. Thompson | 46. David G. Cummins |
| 22. D. H. Timothy | 47. Byron L. Burson |
| 23. C. M. Taliaferro | 48. Robert C. Buckner |
| 24. W. W. Woodhouse Jr. | 49. L. E. Harris |
| 25. Eugene F. McClain | 50. Elver Hodges |

(CONT.)

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|----------------------------|-------------------|
| 51. George Beinhart | 75. Gene L. Spain |
| 52. Ethan C. Holt | |
| 53. Henry A. Fribourg | |
| 54. Eric A. Greenwood | |
| 55. C. H. Gordon | |
| 56. J. C. Burns | |
| 57. R. Bates | |
| 58. S. H. Dobson | |
| 59. E. C. Bashaw | |
| 60. R. C. Leffel | |
| 61. William E. Knight | |
| 62. Earl S. Horner | |
| 63. Willie Cumpiano | |
| 64. William H. Gracia | |
| 65. Rurice Díaz | |
| 66. Ovidio Garcia Molinari | |
| 67. Antonio Sotomayor Ríos | |
| 68. K. G. Shambulingappa | |
| 69. J. Vélez Fortuño | |
| 70. Luis M. Cruz Pérez | |
| 71. José Muriente | |
| 72. A. Rodríguez Cabrera | |
| 73. Roberto Chevres Román | |
| 74. Jaime Vélez Santiago | |

SOUTHERN FORAGE BREEDERS' GROUP

Tuesday, May 6, 1969

Rio Piedras, Puerto Rico

Presiding: R. C. Buckner

Page No.

9:00 a.m. - CALL TO ORDER -- General Announcements and
Business Meeting

GENETIC INCOMPATIBILITIES IN PLANTS

- 9:30 Genetics and Evolution of Incompatibilities in Flowering
Plants. R. C. Leffel, USDA, ARS, Beltsville, Md. 34
- 10:10 Biochemistry, Physiology, and Environmental Variation
of Incompatibility. W. A. Kendall, USDA, ARS,
Lexington, Ky. 35
- 10:50 Inheritance of a Self-Compatibility Response to Temperature
in Diploid Alsike Clover, Trifolium hybridum L. C. E.
Townsend, USDA, ARS, Fort Collins, Colo. 34
- 11:10 RECESS
- Application to Forage Breeding:
- 11:20 Application of Genetic Incompatibilities to Plant
Breeding..Leguminosae. W. E. Knight, USDA, ARS,
State College, Miss. 36
- 11:40 Genetic Incompatibilities in Plants Application to
Forage Breeding ... Gramineae. Robert C. Buckner,
USDA, ARS, Lexington, Ky. 40
- 12:00 Panel Discussion -- R. C. Leffel, Moderator; W. A.
Kendall, C. E. Townsend, W. E. Knight, R. C. Buckner,
J. B. Powell, W. A. Cope, and J. D. Miller.
- 12:30 p.m. LUNCH

UTILIZATION OF APOMIXIS IN FORAGE CROP BREEDING

- 1:30 Evolutionary Significance of Apomixis. E. C. Bashaw, USDA,
ARS, College Station, Texas 41
- 1:45 Genetic Control of Apomixis. C. M. Taliaferro, University
of Oklahoma, Stillwater, Okla. 44

2:00 p.m.	Apomixis in Grass Breeding. Ethan C. Holt, Texas A&M University, College Station, Texas	48
2:15	Panel Discussion -- E. C. Bashaw, Moderator; C. M. Taliaferro and E. C. Holt.	
3:00	RECESS	
	<u>THE TROPICAL GRASS GENUS <u>DIGITARIA</u> AS VIEWED BY</u> <u>PLANT BREEDERS</u>	
3:15-4:30	The Tropical Grass Genus <u>Digitaria</u> as Viewed by Plant Breeders. Participants: S. C. Schank, K. G. Shambulingappa, L. M. Degras, and A. Sotomayor-Rios (Summary)	52
4:30	ADJOURN	

Genetics and Evolution of Incompatibilities
in Flowering Plants

R. C. Leffel, ARS, USDA, Beltsville, Md.

A review of "Genetics and Evolution of Incompatibilities in Flowering Plants" was presented. Crowe's (1964, The evolution of outbreeding in plants. Heredity 19:435-457) classification of systems of genetic incompatibilities was utilized. Research on S gene structure was discussed under categories of polyploidy, genetic linkages, mutations, interspecific relationships, and number of alleles. A rough draft of the paper was available for each Work Group member in attendance and this rough draft was superseded by a revision of June 13, 1969, (34 pages; 55 references). A copy of the paper is available from R. C. Leffel until exhaustion of the limited supply.

Inheritance of a Self-Compatibility Response to
Temperature in Diploid Alsike Clover, Trifolium
hybridum L.

C. E. Townsend, ARS, USDA, Ft. Collins, Colo.

The temperature-sensitive data from diploid alsike clover clones 6-5 and 7-1 were subjected to several genetic hypotheses, and none completely satisfied the data. However, the data were interpreted best by a two-gene model with an interaction between S allele genotype and temperature sensitivity. The absence of one homozygous S genotype in one I_2 progeny was not due to a zygotic lethal, but was due to the inability of one S allele to compete successfully with another in fertilization. For example, the S_6S_6 genotype was not found in the I_2 progeny of clone 7-1 (S_5S_6), but when S_1S_6 plants of the cross 7-1 x 1-5B were selfed, the F_2 progeny contained S_6S_6 genotypes.

(A copy of the paper was available to each in attendance at Southern Forage Breeder's Group meeting).

B
Biochemistry, Physiology, and Environmental

Variation of Incompatibility - X

W. A. Kendall
ARS, USDA, Univ. of Ky.

SUMMARY

Self-incompatibility in Trifolium pratense L. can be prevented in some flowers by relatively high temperatures. The temperature effects occur during the period of anthesis and cause an inactivation of a part of the incompatibility system located in the styles. The heat-treated styles revert back to the original self-incompatible condition within a few hours if held at room temperature. Heat treatments can be utilized to provide self-seed for plant breeding purposes.

It has been suggested by other workers that the incompatibility is caused by an antigen-antibody type of reaction. In studies with excised pistils we were not able to provide data in support of this suggestion from treatments expected to block the reaction.

It has also been suggested that isoenzymes of peroxidase may play a part in the incompatibility mechanism. In studies with excised pistils and various metabolic inhibitors it was inferred that peroxidase may be involved in growth of pollen tubes through styles in which they were compatible, but similar treatments did not affect self-incompatibility.

APPLICATION OF GENETIC INCOMPATIBILITIES
TO PLANT BREEDING..LEGUMINOSEAE^{1/}

W. E. Knight
State College, Mississippi

INTRODUCTION

The Leguminosae have both self- and cross-pollinating agricultural species: peas and soybeans which are grown for seed are highly self-compatible; alfalfa and the Trifolium species which are grown as biennial or perennial forage crops are generally self-incompatible and require cross pollination to produce seed. A number of the annual Trifoliums are self-compatible but highly cross-pollinated. Virtually all diploid species of plants, whether domesticated or wild, have been shown, when investigated, to possess at least one male-sterility locus (Beadle, 1932; Gagnieu, 1951; Jain, 1959). The male-sterility may be due to pollen abortion, failure of anther dehiscence, anther abortion, pistillody of the anthers or other causes. The male sterility gene usually is recessive (Lewis and Crowe, 1956).

Duvick (1966) listed three genetically controlled systems of incompatibility available to plant breeders as follows: (1) genetic male sterility (2) self-incompatibility, and (3) cytoplasmic male sterility.

RED CLOVER, Trifolium pratense L.

The study of the genetics of red clover is greatly facilitated by the fact that we are dealing with a diploid with only seven pairs of chromosomes. Red clover is normally self-incompatible, but a small proportion of the plants are capable of producing a few selfed seeds as a result of pseudo-self-compatibility. True self-compatibility is extremely rare in red clover.

Williams (1937) regarded inbreeding as the most effective, if not the only way, to eliminate undesirable recessives in the species, especially the many chlorophyll-deficient factors. Yet no inbreeding program with the species has resulted in a superior variety, probably because the breeding behavior of the species discourages inbreeding.

^{1/} Complete copies of this paper were available to members of the Southern Forage Breeders Group. The paper included tabular material and 61 references.

Rinke and Johnson (1941) reported an allele for self-fertility (S_f) in red clover. Pollen grains of S_f genotype could affect self-fertilization. They outlined a scheme for using this gene to develop self-pollinated, inbred lines of red clover from which the gene would be eliminated subsequently. The selfed lines would be kept heterozygous for the S_f and several other S alleles.

Leffel (1963) showed data which suggested that, with the proper manipulation of environment and background genotype, self-incompatible inbred lines could be propagated by seed rather than by vegetative multiplication. These lines could be used to produce double-cross hybrid seed: $(S_1S_1 \times S_2S_2) \times (S_3S_3 \times S_4S_4)$. Each inbred would be self-incompatible enough that it would produce almost all hybrid seed when pollen was available from another line. Likewise, each single cross would be self-incompatible but cross compatible with another single cross. Leffel (1963) studied the S-allele genotypes in the l_1 generation of four l_0 plants. He found in total segregation of 32 homozygous (S_1S_1 or S_2S_2) to 47 (S_1S_2) heterozygous plants with no evidence for two classes of homozygotes. Johnston, Taylor and Kendall (1968) studied intercrosses within three l_1 families of red clover and established that two families possessed both of the gametophytic homozygous S-allele classes (S_1S_1 and S_2S_2) along with the heterozygous class S_1S_2 . The other family segregated only one homozygous class (S_1S_1) indicating the possibility of differential growth rates of pollen tubes or from zygotic lethality as proposed by Leffel (1963).

Smith (1968) has identified a male sterile character in red clover and proposes the use of cytoplasmic male-sterility and the S_f allele of the incompatibility gene in the production of hybrids in red clover.

WHITE CLOVER, Trifolium repens L.

It was proposed by Atwood (1945) that a self-fertility gene (S_f) in white clover also could be used to facilitate development of inbred lines. Cohen and Leffel (1964) said difficulty in identifying the S_f gene makes this method of extracting inbred lines impractical. They proposed using pseudo self-compatibility as discussed by Leffel (1963) for red clover and Atwood (1942) for white clover. They found that background genotype influenced the degree of pseudo self-compatibility. Vegetative cuttings, the use of bees, and manipulation of the environment were mentioned as ways to aid in maintaining inbred lines.

ALSIKE CLOVER, Trifolium hybridum L.

Townsend (1965a; 1965b; 1965c) found self-compatible plants in tetraploid and diploid populations of alsike clover. He points out that although Rinke and Johnson (1941) and Atwood (1945) outlined methods of introducing and eliminating the S_f gene in breeding material that the use of the S_f gene factor in developing inbred lines of clover for subsequent production of hybrid varieties has not resulted in the release of a hybrid variety to date. Townsend (1965c) proposed the use of the S_f factor in inheritance studies. Recent studies by Townsend (1966a, 1966b, 1968a, 1968b, 1968c) show the inheritance of the self-incompatibility mechanism in diploid and tetraploid alsike clover and the effect of temperature on the response.

CRIMSON CLOVER, Trifolium incarnatum L.

Crimson clover is a diploid annual with a chromosome complement of $2n=14, 16$. This species is self-fertile but is normally cross-pollinated. Knight (1969) reported a male sterile character in crimson clover. Sterility in this mutant was associated with multiple ovaries and absence of petals. This characteristic will be useful in hybridization in the greenhouse but the use of this character in the field will be limited since bees are not attracted to the seed heads. Inbred lines have been found with low levels of self-fertility. Apparently, the self-incompatible alleles are present in crimson clover but have been selected against through natural and imposed selection pressures for seed production.

ALFALFA, Medicago sativa L.

Alfalfa, Medicago sativa L. is essentially a cross-pollinated auto-tetraploid species, although self-fertilization is possible in most plants. When cross-pollinations are made without emasculation, cross seed are produced in much greater frequency than self seed even though an abundance of self pollen is present on the stigma. Self-incompatibility and the effects of inbreeding have been suggested to be mechanisms that suppress or limit selfing. No clear-cut genetic analysis of self-incompatibility has been given for alfalfa. Alfalfa shows tetrasomic inheritance characteristic of a segmental allo-tetraploid (Tysdal and Kiesselbach, 1944; Dudley and Wilsie, 1957; Markus and Wilsie, 1957). Since polyploidy tends to negate gametophytic self-compatibility-systems (Lewis, 1954), probably the polyploid nature of alfalfa has some bearing on the erratic inheritance patterns of its self-incompatibility. Research on diploid relatives of Medicago sativa may help in understanding the self-compatibility genetics of cultivated alfalfa.

The production of hybrid alfalfa seed via self-incompatibility was proposed by Tyadai and Kiesselbach (1944). In the 20 years since this proposal, many studies have demonstrated appreciable specific combining ability in alfalfa for various economic characters (Frakes et al. 1961 Theurer and Elling, 1964; Kehr and Gardner, 1960) and most researchers have recommended breeding schemes that make maximum use of nonadditive gene action. However, hybrid alfalfa is not yet being produced commercially.

Teweles Seed Company will offer hybrid alfalfa seed in 1970 (McGill, 1969). A 4-way cross will be offered at \$150 per bushel and a top cross for \$125. Hybridization was accomplished using male sterile lines selected from 50,000 plants.

SUMMARY

Which of the basic three methods, i.e., genetic male sterility, self-incompatibility or cytoplasmic male sterility is best to take advantage of hybrid vigor? There is probably no single method that is universally best. We must start from where we are and utilize the system available to us. Duvick (1966) states, when the three systems are compared at their best, the cytoplasmic male-sterile method is easiest to manage. All systems can be useful to the plant breeder.

Genetic Incompatibilities in Plants
Application to forage breeding; Gramineae
Robert C. Buckner, ARS, USDA, Lexington, Ky.

The self-incompatibility system has been reported as occurring in most perennial forage grasses.

Self-incompatibility in the grasses is gametophytic, however, the incompatibility differs from other gametophytic types in that two loci, rather than one, govern the reaction. These two loci are assumed to work, not by duplicating the same incompatibility reaction, but as complements. The incompatibility reaction occurs when alleles at both loci are matched in pollen and style.

The perennial forage grasses are nearly all wind-pollinated and are highly heterozygous. Self-incompatibility is an outbreeding mechanism which maintains a high degree of heterozygosity in a species.

Self-incompatibility of grasses introduces many problems in breeding techniques. In synthetics and recurrent selection schemes, the barriers to or enhancements of recombination caused by specific incompatibility or compatibility in the population are unknown. Very likely the repeatability of various crosses or breeding schemes, even by sampling the same populations, would be low due to the effect of a small number of incompatible alleles.

Inbreeding depression is usually severe in the cross-pollinated grasses and hybrid vigor is easily found. Therefore, F_1 hybrids probably would be desirable if they could be produced economically.

Burton and co-workers have produced superior hybrids of pearl millet, Pensacola Bahiagrass, and Bermuda grass by utilization of the incompatibility system.

EVOLUTIONARY SIGNIFICANCE OF APOMIXIS

E. C. Bashaw

According to Gustafsson (3) the term apomixis was originally suggested by Winkler to distinguish the various forms of asexual reproduction from sexual reproduction or amphimixis. In recent years plant geneticists have tended to restrict use of apomixis to asexual seed formation as used in this report. Seed formation without fertilization was apparently first reported by an Englishman, J. Smith, at a meeting of the Linnean Society in 1839 (Gustafsson, 3). This phenomenon was not reported in higher plants until early in the twentieth century, and another forty years passed before scientists seriously considered the evolutionary significance of apomixis or its potential value in plant breeding. Apparently the early workers failed to visualize the possibilities of asexual seed formation and made no basic distinction between this dynamic phenomenon and reproduction through vegetative organs. The presence or possibility of both sexuality and apomixis in the same plant or species was apparently not considered for many years. Consequently the significance of alternative methods of reproduction was not recognized. As late as 1939, Darlington (2) described apomixis as an evolutionary "blind alley".

Research in the first half of the present century was devoted to descriptive cytological studies and determination of the mechanisms of apomixis. For a time the apomict terminology was extremely complex but, thanks to Gustafsson (3) the terms have been simplified. He classified all plants having asexual seed formation (Agamospermy) into two broad categories: obligate apomicts, those which can reproduce only by apomixis; and facultative apomicts, those which can produce sexual and/or apomictic embryos in the same ovule. He further divided each category into three mechanisms based upon the origin of the cell forming the embryo. This cell can arise directly or indirectly from the megaspore mother cell (diplospory), be derived from somatic cells in the nucellus (apospory), or the embryo can arise directly from nucellar or integumental outgrowths (adventitious embryony). Gustafsson used the term pseudogamy for those cases in which pollination is necessary for seed development and parthenogenesis to denote development of the embryo from an egg nucleus without fertilization. Thus, with only seven basic terms one can easily understand modern apomictic literature.

By 1945, apomixis had been reported in 35 families and several hundred species of higher plants but there was still little experimental information on causal aspects or the fundamental significance of apomixis in speciation. Gustafsson (3) listed the theoretical causes of apomixis as genetic, polyploidy, hybridity or heterozygosity, physiological and hormones. The results of research conducted during

the past 20 years leaves little doubt of a genetic basis for apomixis. Several critical inheritance studies have shown conclusively that apomixis is genetically controlled in certain species. With new information from genetic studies and our present knowledge that most apomictic ecotypes have sexual counterparts, it is now possible to evaluate the probably role of apomixis in evolution. No other biological phenomenon provides such a dynamic reproductive mechanism for genome preservation, polyploid buildup, permanency of heterosis and survival of the derivatives of wide crosses.

Clausen (1) stated that partial apomixis (facultative) functions as an evolutionary equilibrium system in which "the apomictic process is in balance with an almost dormant sexual process that can be invoked and release a part of the stored variability for a time". The ability to store and release variability is obvious in facultative apomicts, being maintained by a delicate balance between sexual and apomictic embryo sacs in the same ovule. In obligate apomicts variability is achieved through two entirely different phenomena; fertilization of unreduced eggs in the apomict (intra or inter-specific), and the ability of the apomict to function as the male parent in crosses with sexual plants. These processes provide the means for increase in ploidy level and variability, while obligate apomixis insures preservation of highly competitive new heterozygous genotypes. The effectiveness of these mechanisms has been demonstrated in several forage grasses.

Fertilization of aposporous eggs has been reported in most apomictic genera. In our research with Paspalum we have noted this phenomenon in both intra and interspecific crosses. In P. dilatatum, we found it relatively easy to produce 70-chromosome hybrids by crossing the apomictic common cultivar ($2n=50$) with a sexual biotype ($2n=40$); whereas the reciprocal cross is almost impossible.

The role of apomixis in species formation is especially evident in genera which contain related sexual and apomictic species capable of hybridization and continuous production of new forms. Since fertility will be preserved in certain offspring through apomixis, distantly related species in close contact may also be expected to contribute substantial numbers of new hybrid types. Some observations in the Paspalum genus illustrate the vital role of apomixis in evolution. Embryological studies showed that 12 out of 20 species in this genus were either obligate apomicts or contained both sexual and apomictic biotypes. Many of the apomicts appear to be species hybrids and their meiotic behavior is sufficiently irregular to cause sterility in a sexual form. Common dallisgrass (10 II + 10 II + 10 I), an apparent trihybrid, illustrates the survival power associated with apomixis.

The evolutionary potential of obligate apomixis is also illustrated by the progeny obtained from hybridization of sexual buffelgrass (Cenchrus ciliaris) and apomictic birdwoodgrass (C. setigerus). The F₁ population contained both sexual and obligate apomictic plants representing a rather complete intergradation between the parents. The parents are quite distinct morphologically and many of the hybrids were so different from either parent that the apomicts might easily be mistaken for new species. The mean fertility of apomictic hybrids was nearly three times that of sexual hybrids, illustrating another powerful evolutionary force favoring apomixis. By completely eliminating the meiotic process, obligate apomixis has an obvious advantage over sexuality in wide crosses. It is apparent from these results that even brief contact between cross-compatible sexual and apomictic plants can give rise to a vast array of new forms. The more competitive apomictic plants resulting from such crosses are ideally equipped for rapid increase in population with no loss in vigor in succeeding generations. It is difficult to imagine a more efficient and effective evolutionary mechanism.

LITERATURE CITED

1. Clausen, Jens. 1954. Caryologia Suppl. 6:469.
2. Darlington, C. D. 1937. The evolution of genetic systems. University Press, Cambridge, England. pp. 149.
3. Gustafsson, A. 1946-47. Lunds Univ. Arsk. N.F. Avid 2, 42(3); 43(2); 43(12). pp. 370.

GENETIC CONTROL OF APOMIXIS

by

C. M. Taliaferro

In plants, agamosperous apomixis (excluding forms of vegetative reproduction) is an intriguing mode of reproduction with widespread and frequent occurrence in the gramineae. Reviewing for just a moment, apomictic reproduction in a plant, or plant group, may be complete (obligate) or only partial (facultative). In facultative apomicts the sexual and asexual processes may operate simultaneously on an individual plant and in both obligate and facultative apomictic groups there may be several mechanisms or combinations of mechanisms involved in the asexual process (apospory, diplospory, parthenogenesis, pseudogamy, etc.). The complexity associated with these operational processes would seem to be matched only by the complexity of the factor(s) causing this phenomenon to exist in the first place.

A number of theories have been advanced to explain the causal basis of apomixis and these have involved physiological factors, hybridity, polyploidy, genetic factors and combinations thereof (5). However, numerous investigations of the inheritance of apomixis, in both facultative and obligate apomictic groups, have produced data leading to the general conclusion that the overall process is genetically controlled and in most groups is recessive to sexuality (2,3,4,5,8, 9,10). Information derived primarily from study of facultative apomictic groups led Stebbins (12) to conclude that apomixis is apparently conditioned by a delicate genetic balance which, when upset by hybridization or other factors may result in reversion to sexuality, sterility, or other types of abnormal genetic behavior. Powers (11) proposed a genetic explanation of apomixis involving 3 gene pairs controlling meiosis, fertilization, and embryonic development, respectively. Under this scheme only the homozygous recessive genotype regularly induces apomictic reproduction.

Studies by Harlan et al. (8) of the nature and inheritance of apomixis in the genera Bothriochloa and Dichanthium clearly indicate the genetic and operational complexity associated with method of reproduction in such facultative agamic complexes. They found that there were 3 independent phenomena operating simultaneously, these being: 1) normal sexual reproduction, 2) parthenogenetic autonomous development of embryos, and 3) nucellar apospory. Furthermore, they found that all apomicts studied had some sexual potential and the degree to which this potential was realized depended upon the synchronization of the

various embryological phenomena. Inheritance studies indicated that apomixis in this agamic complex was dominant to, but independent of, sexuality. Harlan et al. concluded that the various processes and intricate synchronization of the embryological phenomena are under complex genetic control but that, "Apomixis or lack of it, however, is probably rather simply inherited and is controlled by no more than one gene per genome."

Investigations of the nature and control of obligate apomixis, though less extensive than those dealing with facultative groups, indicate that genetic control and certainly operational mechanisms may be less complex. Burton and Forbes (2) used sexual autotetraploid *pensacola bahiagrass* (*Paspalum notatum*) females in crosses with obligate apomictic common *bahiagrass* males to study the inheritance of this mode of reproduction. Ratios of sexual to apomictic progeny in the F_2 suggested to them that obligate apomixis in this material is recessive to sexuality and is controlled by very few recessive genes that often give autotetraploid ratios; but that are apparently influenced to some extent by modifying factors. Their evidence also indicates that the genetic constitution of both male and female influenced the frequency with which apomicts were produced. They found the autotetraploid *pensacola* females reproduced completely by sexual means and that the hybrid progeny from crosses with apomictic males were either completely sexual or obligate apomicts.

In buffelgrass, *Cenchrus ciliaris*, a polymorphic species composed of numerous isomorphic obligate apomictic biotypes, we studied apomictic inheritance using a single sexually reproducing plant discovered in a field of one of the biotypes (1,13). This plant reproduced completely by sexual means but its selfed and hybrid progeny segregated into discrete reproductive phenotypes being either completely sexual or obligate apomicts. Inheritance studies using selfed progeny and sexual female X apomictic male F_1 progeny, indicated genetic control of apomixis by a relatively small number of genes. Based on the ratios of sexual to apomictic progeny in the S_1 and F_1 populations we hypothesized that method of reproduction is governed by two gene pairs, A and B, where gene B induces sexual reproduction and is epistatic to gene A which controls apomixis.

In summary, it is readily apparent that, though extensive evidence exists for genetic control of apomixis, its specific genic inheritance is far from clear-cut. Available evidence strongly suggests that the various forms of apomixis in existence and the associated mechanisms are governed not by a single "standard" genetic system but

more likely by systems which have undergone independent evolution in different plant groups. Harlan et al. (7) state that, "Mechanisms for apomictic reproductions have evolved independently on hundreds of occasions throughout the plant and animal kingdoms". If this be true, then it is only logical to assume that asexual genetic control systems have evolved likewise.

REFERENCES

1. Bashaw, E. C. 1962. Apomixis and sexuality in buffelgrass. Crop Sci. 2:412-415.
2. Burton, G. W. and Ian Forbes, Jr. 1960. The genetics and manipulation of obligate apomixis in common bahiagrass, Paspalum notatum flugge). Intern. Grassl. Cong. Proc. 8:66-71.
3. Carnahan, H. L. and Helen D. Hill. 1961. Cytology and genetics of forage grasses. Bot. Rev. 27:1-62.
4. Gerstel, D. V. and W. Mischane. 1950. On the inheritance of apomixis in Guayule. Bot. Gaz. 115:89-93.
5. Gustafsson, A. 1946. Apomixis in higher plants. Part I. The mechanism of apomixis. Lunds University Arsskr. 42:1-68.
6. _____ 1947a. Apomixis in higher plants. Part II. The causal aspect of apomixis. Lunds University Arsskr. 43:69-180.
7. Harlan, Jack R. and J. M. J. deWet. 1963. Role of apomixis in the evolution of the Bothriochloa-Dichanthium complex. Crop Sci. 3:314-316.
8. _____, M. H. Brooks, D. S. Borgeonkar, J. M. J. deWet. 1964. The nature and inheritance of apomixis in Bothriochloa and Dichanthium. Bot. Gaz. 125:41-46.
9. Muntzing, A. and G. Muntzing. 1945. The mode of reproduction of hybrids between sexual and apomictic Potentilla argentea. Bot. Not. 1945:49-71.
10. Nygren, A. 1953. Studies on the inheritance of apomixis in the genus Poa. Caryologia 6:842-843.

11. Powers, L. 1945. Fertilization without reduction in guayule (Parthenium argentatum Gray) and a hypothesis as to the evolution of apomixis and polyploidy. *Genetics* 30: 323-346.
12. Stebbins, G. L. 1950. Variation and evolution in plants. Columbia Univ. Press. New York.
13. Taliaferro, C. M. and E. C. Bashaw. 1966. Inheritance and control of obligate apomixis in breeding buffelgrass, Pennisetum ciliare. *Crop Sci.* 6:473-476.

APOMIXIS IN GRASS BREEDING

Ethan C. Holt

Geneticists have long recognized the theoretical potential of apomixis in plant breeding, but actual developments are of very recent origin. The contribution of vegetative reproduction in plant breeding (e.g. Coastal bermudagrass) indicates the efficiency that could be possible with apomixis but with the convenience of seed production. In addition, the breeder has the option of recalling specific genes over and over again through hybridization with new sexual parents.

Extensive work has been done with facultative apomixis especially in Poa, but successful use has not been demonstrated because of the instability of the reproductive process. Not until the manipulation of obligate apomixis was accomplished (Burton and Forbes, 1960, and Taliaferro and Bashaw, 1966) has the use of apomixis in breeding begun to be exploited. Prior to this time breeding of obligate apomicts was dependent on selection of types found in nature. In some species, such as dallisgrass, almost no natural variation exists; whereas, in buffelgrass limited variation among but not within accessions was evident. Apomictic breeding requires sexual and obligate apomictic counterparts, with hybrids being either sexual or apomictic and with subsequent generations of the apomicts breeding true, which is the case of obligate apomixis. Thus, the use of obligate apomixis in breeding is dependent on the existence of both apomictic and sexual reproduction in the species

or in material closely enough related to be cross fertile. When these conditions exist combinations or recombinations of characters in apomicts are obtained by hybridizing heterozygous sexual plants with obligate apomicts from which both sexual plants and obligate apomicts are obtained; or selfing the sexual plant which results in both sexuals and apomicts. The former gives a higher proportion of apomicts for evaluation in a reproductive system in which apomixis is recessive. In either case the apomicts will breed true and can be increased for evaluation.

A schematic model (Figure 1) for use in such a breeding program was proposed by Taliaferro and Bashaw (1966). The sexual plants are so heterozygous, at least in buffelgrass, that either F_1 or S_1 plants exhibit heterosis. Apomictic progeny are also generally highly fertile and heterosis is preserved through apomixis.

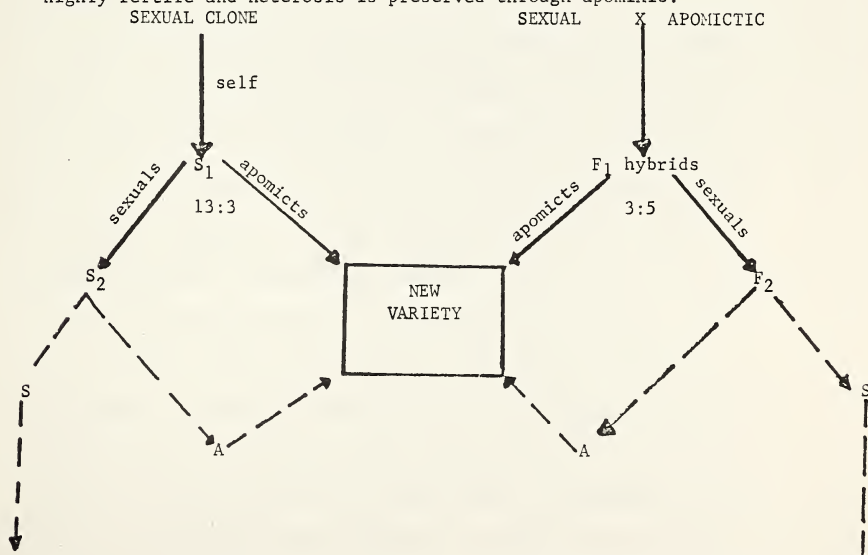


Figure 1. Diagram of methods of developing new apomictic varieties

Apomictic breeding also provides the ultimate in efficiency in transferring characteristics into breeding material. It is possible to evaluate F_1 's for method of reproduction by embryo sac analysis in the spring, clonally propagate desirable plants for seed increase in the fall and have sufficient material for yield testing the second year. Normally seed are collected from F_1 's the first year, progeny rows established for evaluation and seed production the second year and yield tests the third year. Either system is efficient and effective because of the true-breeding characteristics of the apomictic progeny. The system is also efficient because isolation is not necessary for seed production. Seed for increase of apomicts can be collected from adjacent nursery rows or plants.

What are the prospects for use of obligate apomixis in other species or crops? It has been used successfully only in buffelgrass, birdwoodgrass and bahiagrass. Interspecific transfer of genes for apomixis has been accomplished between Cenchrus ciliaris and Cenchrus setigerus, in several Paspalum species and between Cenchrus ciliaris and Pennisetum setaceum. This shows the possibility of the use of wild relatives in which apomixis is known or suspected to exist. Apomictic reproduction exists in Tripsacum dactyloides, an ancestral parent of corn, and in Agropyrons, which are wild relatives of wheat. Some evidence of apomixis has been observed in sorghum species and exists widely in Andropogon species. Certainly in Paspalum species apomixis is common and the problem

may become one of finding a sexual plant. The search for sexual or apomictic counterparts seems well worth the effort because of the great advantages of apomictic breeding. Burton (1966) has concluded that in the future "apomixis will be used to fix desirable genotypes. . . . Sooner than we think, plant breeders will learn to turn apomixis off and on at will; and when they do, their ability to serve mankind will be increased materially."

LITERATURE CITED

- Burton, G. W. 1966. Plant breeding - Prospects for the future. in Plant Breeding Ed. Kenneth J. Fry. Iowa State Univ. Press. Amer.
- Burton, Glenn W. and Ian Forbes, Jr. 1960. The genetics and manipulation of obligate apomixis in common bahiagrass (Paspalum notatum Flugge) Eighth Int. Grassl. Cong. Proc. 66-71.
- Simpson, C. E. and E. C. Bashaw. 1969. Cytology and reproductive characteristics in Pennisetum setaceum. Amer. J. Bot. 56:31-36.
- Taliaferro, C. M. and E. C. Bashaw. 1966. Inheritance and control of obligate apomixis in breeding buffelgrass. Crop Sci. 6:473-476.

THE TROPICAL GRASS GENUS DIGITARIA AS VIEWED BY PLANT BREEDERS

[Summary of the symposium presented May 6, 1969 to the Southern Forage Breeders' Group at Rio Piedras, P. R.]

Participants: S. C. Schank
K. G. Shambulingappa
L. M. Degras
A. Sotomayor-Rios

Research on plant breeding within the genus Digitaria has resulted in more than thirty published papers during the past decade. Dr. Schank distributed a three page bibliography on Digitaria breeding and briefly outlined the hybridization techniques used at Florida. Mutual pollination has been very successful in both interspecific and intraspecific crosses, with hundreds of such crosses accomplished each year at the Florida station.

K. G. Shambulingappa reported on the grass morphology of pachytene chromosomes in nine accessions of Digitaria. Slides of pollen mother cells were shown of diploid, tetraploid and hexaploid plants at pachytene of meiosis. Dr. Shambulingappa stated "... A comparative study of pachytene chromosome morphology amongst the diploids, and between diploids and tetraploids has been suggested to gather information towards the understanding of the origin, evolution, and identification of parental species of several tetraploids. The wealth of information so obtained would ultimately benefit the forage breeding programme."

Dr. L. M. Degras and F. Jailloux (Guadeloupe) presented a seven-teen page paper entitled "Prospects for disease and insect resistance in Digitaria." The complete paper may be obtained by writing to Dr. Degras, Centre de Recherches Agronomiques des Antilles et de Guyane Domaine Duclos Petit-Bourg, Guadeloupe, French West Indies. Space limitations allow only the summary to be published with the conference report. Summary: Degras and Jailloux reported five fungus diseases on Digitaria namely rust, Puccinia oahuensis; blast, Piricularia grisea; Mycosphaerella tassiana; Rhizoctonia solani; and Ephelis. The latter three are less important fungus diseases. Five PI's were reported to be resistant to artificial inoculation of rust. Blast is linked more closely to the juvenile stage and to nitrogen fertilization, but 10 PI's appear to be resistant to blast.

The final symposium speaker, Dr. Sotomayor-Rios, presented data on forage yields and plant character correlations in thirty Digitarias at Rio Piedras and yields on twenty selections at Corozal. At the Rio Piedras location, dry matter yields ranged from 15,841 to 40,484 pounds per acre yearly. One selection, D. eriantha (P.R.P.I. 5277), outyielded the other Digitarias including pangolagrass at the 5% level.

SOUTHERN FORAGE PHYSIOLOGY AND ECOLOGY
WORK GROUP

Tuesday, May 6, 1969
Rio Piedras, Puerto Rico

Presiding: E. George Beinhart, Jr.

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	A. Production capacities and limitations of tropical forage. (Summary)	
	B. Approaches to research and extension with forages in tropical areas.	
	(Panel Coordinator: D. S. Chamblee: N. C. State University); Participants: S. H. Dobson, D. H. Timothy, and W. W. Woodhouse, Jr.	
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TROPICAL FORAGE PRODUCTION AS VIEWED

by Scientists with Temperate-Zone Backgrounds and with Limited Tropical Experience. Panel Coordinator D. S. Chamblee, participants: S. H. Dobson, D. H. Timothy, and W. W. Woodhouse, Jr.

A broad look at forages in the tropical areas of Peru from the research viewpoint. D. S. Chamblee

When I left Peru in 1964, the research program of the SIPA National Forage Program in Peru was conducting experiments under 10 line projects, more than 75% of the total effort being expended on the following listed 5. As evidenced by these titles we were attempting to resolve practical problems, most of the studies being field oriented.

1. Establishment of introductory nurseries for the preliminary evaluation of forage species.
2. Studies of level of plant response and time of application with N, P, K on pure grass stands, and on legumes and legume-grass mixtures.
3. Studies to determine best methods of establishment and system of physical management of principal forages of Peru.
4. Collection, evaluation and improvement through selection and breeding of alfalfa.
5. Studies to determine the nutritive value, productive capacity and system of management of important forage species with animals in grazing trials.

I am outlining below some excerpts from my final report (1964) in Peru which indicate some of the production capacities of the principal forages and some of the major species potentially adapted to the area.

JUNGLE - PERU 1964

"In forage investigations in the jungle 25 grasses and 14 legumes species have been introduced and tested (does not include different varieties of a species.)

"To date those showing most promise as grazing plants are Pangola, (Digitaria decumbens), Castilla (Panicum maximum), Yaragua (Hyparrhenia rufa) and Gramalote (Panicum purpurascens). The grasses which are used as "cut forage" that have produced the most forage are elefante (Pennisetum purpureum) and Maicillo (Axonopus scoparius).

"As for legumes tropical kudzu (Pueraria phaseloides) and Centrosema (Centrosema pubescens) have shown the most promise.

"In 1963 and 1964 new studies were initiated on the management and fertility requirements of several of the above grasses in the jungle area.

"Plans are being made for the development in the near future of a chain of experimental stations in the Huallaga Valley of the jungle including stations at Tulumayo, Juanjui, Bellavista and Yurimaguas. Juanjui and Bellavista receive approximately 1200 mm of rainfall a year, having a dry period in May, June and July annually. In addition to other studies which should include introductory grass-legume gardens and variety trials, basic fertility studies to determine the nutrient requirements of the principal grasses and legumes should be placed in the area.

"I will list a few species and varieties of plants below which I think should receive further study in the near future in the jungle area of Peru. Some of these have not been introduced into this country: Suwannee Bermuda Grass (Cynodon dactylon), Sorghums (Sorghum vulgare), Perennial soybeans (Glycine javanica), Alfalfa (Medicago sativa), Dolichos lablab, Starr grass (Cynodon plectostachyum).

"Addendum:

"As of 1969, I would add the following species to the list of those which should be introduced for testing. (Some have been introduced in recent years): Brachiaria brizantha, Brachiaria ruziziensis, Erichloa polystachya, Panicum coloratum, Panicum maximum var Trichoglume, Setaria spaceata, Desmodium intortum, Lotononis bainesii, Phaseolus atropurpureus, Stylosanthes gracilis, Stylosanthes humilis, Stylosanthes guyanensis.

COAST

"On the coast of Peru most of the species of forages that thrive under the natural rainfall condition of the jungle are adapted under irrigation. However, certain species such as Pangola and bermuda do not produce well in the coastal areas that have a cool winter period.

"Alfalfa is one of the principal forages utilized under irrigation in the coastal area of Peru. With the exception of Moapa all of the introduced varieties of alfalfa have proven inferior to the local varieties. (on the coast).

"In recent years the annual sorghums have proven to be an excellent source of forage in the coastal area of Peru under irrigation. For cutting and for silage, Elefante has given excellent results on the coast, producing more than 200 tons of green matter annually per hectare when properly fertilized. Studies are underway on management and fertilization of this important plant and more knowledge is needed concerning its nutritional value.

"Under irrigation the following grasses merit intensive studies on their fertility and management requirements in coastal Peru: Elefante (Pennisetum purpureum), Gramalote (Panicum purpurascens), Gordura (Melinis

minutiflora), Yaragua (Hyparrhenia rufa), Buffel (Pennisetum ciliare), Sorghums (Sorghum vulgare), Castilla (Panicum maximum).

"A preliminary collection of ecotypes of alfalfa have been made and established in Lima. Alfalfa merits research efforts in all facets. A genetic improvement program has been initiated."

B Soil Fertility Research, W. W. Woodhouse, Jr.

1. Research objectives

- a. There will be a real need to determine the potential without regard to immediate economic prospects. Until we know what is possible, how can we know whether it's feasible or not? Also, the economics of production change. Who in the southeastern United States of America would have thought 30 years ago of N at less than 10¢/lb (in 1969 dollars)?
 - b. Develop something that can be used now. This is of equal importance! Some quick improvements are essential in attracting attention and support.
 - c. "Basic research" should be problem-oriented. Few underdeveloped nations can afford to put very much of their scarce money and talent into studies that are not aimed at solutions to their particular problems. On the other hand, there will be a continuing need for fundamental studies on, for example, tropical soils.
2. Tropical soils (and plants) are similar in principle to those encountered in the temperate zones but there are differences. Take soil acidity, for example! Low pH does not necessarily mean response to lime.
- a. Many tropical plants are quite tolerant to low pH. With most legumes, the rhizobia are alkali-producers, rather than the acid-producers as is the case with alfalfa and white clover.
 - b. Four ounces of sodium molybdate may replace a ton of lime, where legumes are involved.

On the other hand, lime may be all-important with some plants, as with the campo cerrado soils in Brazil.

In other words, one must keep in mind that he's away from home, and resist jumping to the obvious conclusion. And Investigate first!

3. Legumes

In the past legumes have been a major source of N in temperate grasslands. With fertilizer N becoming cheap and plentiful, there is a rapid shift to grass + N for higher yields, dependability and simplicity. This has great appeal in the tropics since (1) tropical grasses can be

extremely responsive to N, (2) tropical legumes have not been studied extensively, and are often low-yielding, harder to establish, and less palatable.

The grass + N system does have great potential in the tropics, under the right conditions, i.e., high quality grasses, available N, and intensive management. Puerto Rico is an excellent example! However, vast areas of the tropics are inaccessible and likely to remain under extensive management for some time to come. For this reason there is a great need for more extensive and more enlightened use of forage legumes in these areas. This will require a great deal of research, both basic and applied.

4. A large preponderance of the needed research is of an adaptive nature, often requiring field experimentation.

Two real problems with field experiments in most developing countries are:

- a. Limiting numbers to those that can be properly executed.
- b. Obtaining adequate supervision by competent personnel.

Panel Discussion. D. H. Timothy

I have been asked to react to the topic from a breeder's viewpoint. My first remark would be that when a man from the temperate zone hits the tropics for the first time, he is overwhelmed by the luxuriance and variation of the vegetation as well as the geographic and edaphic diversity and variation. He is also poorly prepared, being trained in genetics with a minor in biochemistry, physiology, or statistics. His scope and viewpoint are restricted as he has little knowledge of agrostology, plant geography, natural history, etc. To ameliorate these deficiencies, it is hoped that more educational institutions will begin using a broader approach or make use of facilities such as those of The Organization of Tropical Studies.

The approach to breeding is somewhat clouded in that the tropical species and genera are not well known, and representative or comprehensive collections are difficult or impossible to obtain. Selection criteria associated with ecology and physiology, in turn related to management, soils, intensive or extensive use, are equally hazy. No predictive process really works in choosing a species which might be useful, although establishment of the above criteria on representative arrays of a number of species would be helpful in eliminating many from further consideration.

Plant exploration and collection has serious implications on breeding as well as on physiology and ecology of cultivated plants. Unless one has a guarantee of being inordinately lucky, it is foolish to begin a

breeding program with limited diversity of germplasm. Much of the success of the various Rockefeller programs with wheat, rice and corn can be attributed to tremendous sources of germplasm upon which to draw. When I was director of the Rockefeller-Colombian corn program, we had the entire Latin American collection of indigenous strains of maize at our immediate disposal--over 12,000 varieties. The key to success of the program was not just diversity but the right kinds of diversity. There is both desirable and undesirable diversity and the breeder's job is to determine which is the best and put it together. If our only germplasm resources had been restricted to Colombian material we would have been severely limited and our progress much less. You, as ecologists, or physiologists, or agronomists, are just as limited in your research as the breeder when dearth of material is concerned. With a few exceptions, yield per se of forage grasses has not been increased appreciably. One possible explanation for this may be limited germplasm. The advances of the Australian forage program are directly attributable to their interest and effort in exploration for tropical grasses and legumes. While our government has not supported tropical forage exploration to that extent, the situation creates an excellent opportunity for those going on tropical assignments to do some collecting whenever the opportunity arises.

There are many barriers to wide spread use of tropical legumes: incompatibility systems, self sterility, alkaloids, pubescence, little known disease and insect reactions, and animal responses. Much the same can be said for the grasses, which additionally are usually low in protein as well. Perhaps more emphasis should be placed on carbohydrates rather than protein. The dry matter production of the tropical grasses is well established. It is possible to improve production under certain management conditions so that much of the low quality criticism is meaningless -- at least for beef cattle, and in some instances dairy cattle as well. Spectacular success has been had with tropical grasses and high nitrogen usage. Wherever nitrogen is cheap, it should be used. Otherwise, we tend to limit the grass management system to the requirements of the legume. There are few legumes which can compete with a tropical grass in a pasture when managed for the highest production possible. This is in conflict with the Australian philosophy but their conditions and requirements are different. They have vast expanses of grassland which suffer prolonged and seasonal drought. Nitrogen in many areas of their continent is expensive in many areas, and prohibitive in cost in many reaches of the outback. These conditions and the extensive management systems are well suited to a grass-legume association. Many areas of the American Tropics are equally suited to a grass-legume management system rather than a grass-high nitrogen scheme.

A great deal of research is needed on tropical grasses and legumes, in the tropics and subtropics. Much of this research must be of an adaptive nature. In terms of my own background and experience, I have found it useful to assume that everything I know must be modified. Many of the principles I have learned are often valid but not always. The exceptions keep occurring because most of the principles were based on limited temperate material and in a temperate background. The techniques used to determine the principles have often served better on new material

than the principles themselves, and these also may need modification. From this another principle emerges, often stated previously by others -- that while results from an experiment may be meaningful and useful in one area, they cannot be trans-shipped from the temperate zone to the tropics anymore than from one area of the temperate zone to another, or from one zone of the tropics to another.

Extension in Peru. S. H. Dobson

I am going to deal with the business of reaching the farm people with a message for changing at least some phases of their farming practices. There, as here, the more research basis you have the easier the job is. I shall illustrate primarily with forages but not all.

Let's look at the people, who they are, where they are, the need for change and a few examples of change.

First of all, Peru is a country of contrasts - high, low; rich, poor; tropical, snow; hot-wet, hot-dry; and hot-cold in the same day.

One fourth of 1% of the farm families own 60% of the land; 95% of the farmers control only 10% of the land. Those who do not own land belong to the land, owners must take care of them.

Over 50% of the farm families live above 10,000 feet, over 50% do not speak the official language.

Good roads are scarce but being developed. The mail service is slow, TV is just coming, but radios are quite common. The farmers are primarily Indians in the Mountains and Mestizos and Indians in the coast.

We work with the established governmental agencies and institutions. Their Extension Service is quite similar to ours.

Let's start out in the Sierra with some examples of successful demonstrations. We don't think the national food problem will be solved in the mountainous area, but a lot of the social and political problem is there. In some of the most intensive areas in the Sierra where corn grows up to elevations as high as 11,000 feet, there is a danger of sleet or hail during the entire growing season. This really shocks an agronomist to wake up in July (February there) with two inches of sleet or snow on the ground.

In Peru, the white potato is the staple crop (they say that the Irish potato should be called the Peruvian potato). Here improved technology exists: new varieties along with some knowledge of fertility responses are available. A rather extensive small all-practice demonstration program was initiated in the Sierra where yields were doubled and quadrupled over the customary varieties and practices. Field meetings were held at the various demonstrations and it appeared that as rapidly as seed can be made available, potato production will be increased in the Sierra. The story

is not quite this simple however, because for the vast number of farmers in the area, they simply do not have the money to purchase the additional inputs of seeds and fertilizer and, in some cases, simple irrigation equipment. For this reason, the Peruvian government with the support of the U. S. government has initiated a credit program for the small and medium size farmers.

Another example of successful demonstrations was a small garden project of the N. C. technicians working with the home demonstration agents in the mountains. One club with a membership of 35 women successfully established small garden plots with 26 of the members in the first year. This was some accomplishment when it is realized that the agents had to start with plant beds, transplanting, supplemental irrigation, fertilizing the plants, cultivation and production of the plants, teaching them what part of the plant to use for food and how to prepare it for table consumption. This practice appears to be catching on in the Puno area.

The most successful story as far as food production increase is the silo story in the Arequipa area. Here a fairly large milk plant is purchasing the milk from several thousand small dairymen for producing condensed milk. They have some of the best blood lines from the U. S. and other parts of the world, but have low production and poor butterfat tests. It was decided that the low production was very likely due to a limited feed intake and the low butterfat tests were likely due to the milking habits being followed. Corn is produced quite successfully in the area but primarily as a food for human consumption. It was decided to try a few demonstration silage corn plots on a few farms to measure the changes in milk production on these farms against cost and returns to the farmer. Within two years from the time the first temporary silo was built and the first feeding demonstration of corn silage was held, 80 silos were in the various stages of planning, construction, or filling.

In summary, we feel that the demonstration there is the best single teaching method. Slides and movies are quite good. In so many of the areas though a portable generator has to be carried to show them. In other words, farmers responded to about the same teaching techniques in Peru that they do here.

Progress can and is being made but we have to remember that we are working in a culture of many hundred years of customs and where the capability of making technical change is extremely limited by finances.

While the pace is slow, people by and large do seem to want something better and are willing to work for it if they can reap the benefits.

It is certainly my feelings and the feelings of most of the N. C. technicians that the farmers respected the U. S. and U. S. technicians. Due to the size of the farming units, the educational inputs will be high in bringing about changes or increases in food production. Technicians could be much more influential as far as increasing food production by working with the larger holding but this would have social and political implications.

PEDOLOGICAL AND CLIMATIC CONSIDERATIONS IN
HAWAIIAN PASTURE RESEARCH

A. Sheldon Whitney ... University of Hawaii

Agriculture in Hawaii is characterized by large differences in soil and climate over very short distances. Soils range from unweathered volcanic rock or ash to highly weathered iron, titanium, and aluminum oxides. Except for recent deposits, degree of weathering is highly related to rainfall. Thus most soils with sufficient rainfall for high production of pasture are severely depleted of bases and other nutrients, have toxic levels of aluminum, and fix large amounts of phosphorus, especially in the subsoil. Some other soil conditions affecting pasture production are excessive drainage (i.e. rockland and cinder cones), inadequate drainage (i.e. former paddy areas), poor aeration (i.e. certain moist ash soils), and supply of sulfur as influenced by amount of rainfall, distance from seas, and volcanic eruptions.

Rainfall is greatest on the windward slopes and also immediately to the lee of those summits which approximate the inversion zone. It increases with elevation on the windward slopes until the inversion zone is reached; higher slopes are relatively dry. Rainfall in leeward areas is primarily from convection winds and erratic southeasterly storms. Average annual temperature decreases approximately 3°F for each 1000' increase in elevation, except for cooler temperatures below the inversion zone.

By properly selecting sampling stations, it is possible to sample sites with varying temperature but similar rainfall, or vice versa. It is also possible to sample sites which compare in many respects with stations elsewhere in the tropics. Since changes in soil and climate are also reflected in the vegetation, the delineation of a number of Ecological Zones has proved useful in the conduct of pasture and forage research. It is our hope that advances in pedology, ecology and climatology will permit closer coordination of pasture research between Hawaii and other areas of the tropics and subtropics.

PROGRAM

SOUTHERN FORAGE EXTENSION WORK GROUP

Tuesday, May 6, 1969 (P.M.)

Presiding: S. H. Dobson, Chairman

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Southern Pasture and Forage Crops Improvement Conference

Extension Work Group--Puerto Rico

May 6, 1969

The Adoption Lag

S. H. Dobson - Extension Professor

Time lag between the discovery of a principle and its application on many farms is a well documented fact. This is true in crop varieties, fertility practices and no doubt in other areas of endeavor. In our constant efforts to shorten this time lapse, we must recognize that it has many facets. Each of these lags will require a different solution! For example it does no good to demonstrate a superior variety if the seed or if some other inputs are not available. Few changes stand alone so their influence on other practices must be appreciated and understood before a practice is adopted.

Let's take two cases: probably the most classic example is hybrid corn. The principle of heterosis was pretty well established and understood, by a few people, by 1910. It was not until 1933 that half the corn planted in the U. S. was hybrids and for us in the South, it was much later than that.

Let's take an example closer to home, in North Carolina; that of Ladino clover. It was planted first by the experiment station in the spring of 1891. For the growing season of 1892 and 1893, ladino clover produced twice as much forage as any other grazing type legume. It was observed in detail, harvests made, and yields recorded. It made few seed, was not annually fertilized and apparently disappeared in 3 years. Because of lack of seed formation and the general farmer practice of only occasional fertilization of pastures, the judgement was made that ladino clover could not "go" in the state at that time and was never made a part of the experiment station's recommendations. The simple facts are that had it been recommended, the fertilizer industry was not developed to the point where it could supply the nutrients that were required, at a reasonable price, to grow the ladino. Fifty years later, the ladino clover was tried again, not far from the original site. By this time "heavy" fertilization had been talked about and had been accepted on some horticultural and field crops but certainly not on pastures. Rates of up to 5 times the normal suggestion were used, and ladino clover grew quite well. In other words, the results were similar to 50 years earlier,

where the yield was nearly doubled. Apparently there were other limitations because even in small areas, failures occurred, we did not know the reason why and these stared us in the face like a big block wall. At that time, we faced the possibility that these failures were accidental, but maybe they were really telling us something. Certainly these failures served as a warning! About this time, because ladino was so spectacular where it succeeded, and fertilizer had become relatively available, farmers began to try it and some real success stories developed, drowning out all cautions and failures that occurred. Everyone jumped on the ladino clover bandwagon and promoted it to the sky. Through the ASC program, practically every farmer who seeded pastures, seeded ladino clover. We built up to the neighborhood of 1,000,000 acres of ladino clover from one end of the state to the other in a relatively short period of time. What happened was more farmers got seed than got a complete set of instructions. Bloat set in, milk favors began to show up, some of the normal failures began to show up until the bad things began to drown out the good things about ladino in the eyes of the public. The tide reversed itself, flowing real strongly for a short period of time and ebbing almost as strongly in about the same period of time.

Now we are on a plateau, many farmers are growing ladino clover but many are equally convinced that they cannot grow ladino. In fact on some of our college farms, that have been in clover pastures off and on for 20 years, we have come back into them using a rotation system of annual grasses and ladino clover. The clover is going out in 2 or 3 years.

Now this persistence problem is not new! It was recognized from the beginning that some problems existed. Finally a research program was set up at Clemson University by the S. C. Experiment Station and the USDA, as a regional project.

Some 6 or 7 years ago, strains were released for testing in the states of the area and one was named Tillman in 1965. Our variety tests indicated that it is the superior strain for us. We added this to the list of suggestions but we are still looking for our first commercial seed of this new and superior variety.

In appraising the present situation and trying to decide where to go from here, there are several factors that must be considered. No doubt we will make some of the same errors of judgement that were made in 1945 and

available to us, and with the availability and lower prices of nitrogen accompanied with the rather extensive sales efforts on nitrogen, the grass-nitrogen program is being sold as a competitive system. The University regards the nitrogen-grass and the legume-grass systems as complimentary and we are using this approach. However, it is more complicated and will require more educational inputs to produce legume-grass than the more simple grass-nitrogen program. The joker in the deal is that to get the animal performance from grass more careful animal management is required.

Now let's go back and look at these lags and identify them. The fifty year lag from 1895 to 1945 could be one where simply the information was way ahead of its time. In other words, to grow ladino, fertility was required in amounts that were not available and could not be supplied. For simplification we will call this unavailable input lag. Whether or not we needed to wait fifty years to try it again is a matter of some debate. The lag between the second attempt and the mass acceptance was relatively short but it is evident that some technical information was and is lacking. The professional workers actually tried to be cautious because of the problem from causes still unknown. This we call the technology lag.

It was pretty well known by this time that ladino would require heavy initial fertilization and annual applications to maintain it. At this point in time, practically no farmer, not even the leading farmers had accepted this concept. This one we must call the education lag.

The bloat problem was a real one and remained so for nearly 20 years but now appears to be under control--another technology lag. There was a definite extension lag in teaching the facts of proper soil selection, failure extracted a fairly heavy tuition. Here is the classic example where it is real easy to promote but difficult to educate masses of farmers to the several production, utilization, and management details that are required to succeed properly in any new crop.

We admitted that we are now on a plateau which is just another way of saying we are in a time lag which we have identified as being a complicated one. A part of it is a lag of technology, a part is lag in availability of seed of a superior variety. We think part of it is a question of adapting and combining what is known with the farmers' resources...The adaption lag.

Let me say a little more about the educational part of the adoption

it is no longer sufficient to think in terms of a one practice promotion program. But that we must put all of the known factors together in a system tailored to the individual farm with his land, labor, management resources where inputs are measured and returns compared to the costs of these inputs. In other words, for some changes the farmer wants not only the complete packet of production, management and utilization practices but he wants to know what will be the costs and the returns. In other words we have to be sure that there is no profit lag.

One other lag that runs through many case studies is one that I shall call the overcautious lag. This is especially true of us as professional workers.

The adoption lag, this is real. Some parts are defined as follows:

1. The overcautions lag - on the part of professional workers.
2. The availability of input lag (many times we need to work closer with industry)
3. The technology lag - sometimes some key parts are missing
4. The educational lag
 - a. Failure to provide enough educational inputs to reach the number of farmers involved (Sometime we don't estimate the audience properly)
 - b. Adaption lag - This is the one extension specialists must move into much stronger.
 - c. Economic lag.- In forages we have been slow in developing means of measuring costs and returns for our suggested practices. Maybe there has been a profit lag.

Methods Used in Tennessee to Shorten the Adoption Lag Concerning Corn Silage Production and Utilization - Joe D. Burns, University of Tennessee

About ten years ago the dairy, animal husbandry, agricultural engineering, and agronomy specialists reviewed the corn silage situation in Tennessee. There was a deficit of high quality stored forage for dairy cattle and a deficit of high quality stored forage for fattening feeder cattle with an additional opportunity to utilize silage in a wintering program for beef cows.

Our long term objective was to supply adequate amounts of high quality corn silage as the major source of silage for dairy cattle, feeder cattle, and in the case of beef cows, in those situations where silage fitted into the feed program. Recent research findings had shown corn silage to be the most economical source of high quality silage. New production research information, plant population, nitrogen and potassium rates, planting dates, weed control chemicals, and stage to harvest was available but had not been put into use by farmers. Machine adjustments, types of silos and silo covers, methods of filling silos and feeding cattle, and type of feeding bunks and headgates were the major items concerning the agricultural engineers, dairy and beef cattle specialists.

The quality rating or judging of the silage was deemed important as a method of getting farmers to realize they needed to improve their production, storage and feeding methods.

County silage meetings were held. The agronomist judged silage samples from farmer's silos before the meeting started and discussed "what makes high quality corn silage" in the meeting, using local silage samples as examples.

He also discussed "methods of producing high yields of high quality corn for silage." The agricultural engineer discussed "how to chop, store and transport silage"; and the dairyman or beef cattle specialist discussed "how silage fits into a feeding program."

Average Quality Scores for Silage Samples From
Different Types of Silos, 918 Samples, 1963-65

	Upright Silo		Trench or Bunker Silo	
	Roof	No Roof	Plastic Cover	No Cover
Average Score	76	74	73	70
Range	<u>Poor to Excellent</u>	<u>Poor to Good</u>	<u>Poor to Good</u>	<u>Poor to Good</u>
No. of Samples	60 - 94	51 - 85	47 - 86	57 - 82
	315	134	424	45

Quality Ratings: 90-100, excellent silage; 80-89, good silage; 65-79, fair silage; 64 and below, poor silage.

1. The average quality scores of corn silage samples were highest for upright silos with roofs, second highest without roofs, third for horizontal silos with plastic covers and lowest for horizontal silos without covers.
2. The wide range of silage scores in each type of silo indicates that management is more important than type of silo.
3. These are quality ratings of the silage samples, but research has shown that total spoilage losses are least with the covered upright silo and increase generally in this order: uncovered upright next, followed by the covered horizontal and with the greatest spoilage in the uncovered horizontal silo.

Several county field days were held to demonstrate to farmers the correct stage to harvest corn for silage and to encourage the use of recommended silage preservation practices, such as excluding air by the use of plastic covers, clean cutting, and fast filling. Many corn production demonstrations were conducted showing the effect of using recommended practices.

Dr. Charles F. Rogers, Agricultural Consultant, helped to develop the Tennessee silage program along with the silage scorecards and was the silage judge at the First North American Silage Show which was a part of the Second National Grassland Field Day held in Tennessee in 1965. Every part of the silage making, storing and feeding operation was demonstrated at this Grassland Field Day.

We had about five times as many tons of corn silage being produced in Tennessee in 1968 as compared to 1958, i.e., in 1958, 31,000 acres @ 7.7 tons per acre equals 239,000 tons of corn silage; in 1968, 102,000 acres @ 11.5 tons per acre equals 1,173,000 tons of corn silage.

Forage Ahead with Meat and Milk!

FORAGE ON-FARM TEST-DEMONSTRATIONS
TO SHOW ECONOMIC VALUE OF A PRACTICE

by

Dr. Harlan E. White, Extension Specialist, Forages, VPI

The test-demonstration program in Extension Agronomy at VPI was formally initiated in 1968, with approval for funding of technician help and the purchase of the necessary equipment. This program is not intended to conduct original research, but to demonstrate to the farmer, under his local conditions, principles and practices already established by research workers. The same replicated demonstration plots provide additional data on a particular practice and furnish the farmer with specific information to show him "how much" he can expect from adopting the practice. I will attempt to briefly summarize several of the Virginia forage test-demonstrations in progress which are aimed at showing the economic value of a practice.

In Virginia, we have thousands of acres of predominately bluegrass-white clover pasture on steep mountain soils. These are often highly productive if fertilized and managed properly. Since in many instances these pastures are too steep to fertilize with conventional equipment, fertilization by helicopter or airplane is being utilized. To obtain additional information on the expected yield increase and species changes on these steep pastures, four replicated test-demonstrations were established in 1968 utilizing 4' x 4' wire cages. Yield data from the first year indicate a very favorable response to fertilization. This work will be continued for several years without further addition of fertilizer to follow the long-term response. This will provide a basis for economic analysis of this practice.

Along these same lines, in a non-replicated project, a 100-acre boundary of run-down mountain pasture is being utilized as a test-demonstration area. Response to aerial fertilization, brush removal, weed control, and good grazing management will be followed by changes in carrying capacity and meat production per acre.

Curled and Musk thistles are a serious threat to productive pastures in about 40 Western Virginia counties. To show the losses in pasture production due to infestation by these weeds, 3 test-demonstrations utilizing 4' x 4' wire cages were conducted, with selected County Extension personnel doing the actual harvesting. Results indicate that one thistle plant per 16 sq. ft. reduced pasture production by an average of 23% compared to an adjacent area free of thistles. This illustrates the economic importance of controlling these weeds.

Due to problems in controlling the alfalfa weevil and lower costs of nitrogen fertilizer, many farmers have become interested in orchard-grass hay production. Four replicated test-demonstrations are in progress utilizing 0, 50, 100, 200, and 400 lbs. of nitrogen per acre. Yields in 1968 varied from 2.0 to 6.6 tons of 12% moisture forage per acre. When additional data are available from these plots, economic analyses will be made.

An all-practice one-acre alfalfa production demonstration was conducted in cooperation with an Extension Agent, Agriculture, and a farmer in his county. Accurate records were kept of all costs and yields. The farmer produced 5.4 tons of hay, which enabled him to show a net return of \$122 per acre. This will be continued in 1969.

In order to demonstrate and obtain data on the increase in length of grazing season or additional feed production by overseeding cool season forages in Coastal bermudagrass, a test-demonstration was initiated with 15 different species overseeded. Among these were rye, ryegrass, tall fescue, and crimson clover seeded separately for grazing; barley and wheat for silage and for grain. Yields of both the overseeded crop and the Coastal bermuda will be recorded for the season.

The test-demonstration program is a most helpful educational tool for encouraging the adoption of a beneficial practice by showing that it will work under conditions similar to those of the farmer. Each test-demonstration is on a farm within easy reach of neighboring farmers who have the opportunity to visit the area regularly to follow its progress and to participate in discussions at that location on more formal occasions such as county tours. Having reliable yield and other performance data available from the demonstration plots or areas provides the farmer with specific values to use when he pushes his pencil to decide for himself if the adoption of the practice would be profitable to him. The program also actively involves the County Extension Agent and offers him the opportunity to become thoroughly familiar with procedures and results which he is anxious to pass along to farmers.

Using On-Farm Tests To Shorten The Adoption Lag In Forages

Developing Management Systems

Carl T. Blake, Extension Professor

Certainly, we would all agree that there has been, and still is, an adoption lag in forages. And, as has been pointed out earlier, we in North Carolina have suffered rather acutely from this lag.

Now, having recognized this and failing to like this somewhat negative position, we decided to concentrate some effort toward reversing it. Thus, we went to work to develop some management systems wherein we could show beef producers, and to some extent dairymen, how they could select forage crops to fit their soils and livestock, produce high yields of high quality feedstuffs, utilize the forages through proper grazing and/or storage, and come out with a higher net income. The latter phrase - more money in the pocket - was the key in getting and keeping their attention.

So, when people who were approached through the agents asked whether it really would pay, we had a question ready for them - are you willing to help us find out. Then, if they were ready to put up, we set up demonstrations to attempt to get some of the answers.

In most cases, we encountered farms that were, and had been for years, depending almost solely on a pure stand of fescue -- no clover, no millet or other summer graze, and very little winter feed. The fescue stands varied from good to very poor. Our first assessment was the soil type - what would grow well on the soils involved. In most cases there was sufficient land to grow pure fescue; a mixture of ladino clover and fescue; millet, sorghum-sudan, or Coastal bermudagrass; and silage, if needed. In other words, we could graze for 9 to 10 months with proper plant selection.

Then, we went about getting some of the old "fescue" stands destroyed. This was accomplished by complete seedbed preparation, liming and fertilizing to correct severe deficiencies, and seeding pearl millet or sorghum-sudan at one-fourth acre per animal unit. That fall, late summer or early fall, this was torn up and the land reseeded to ladino clover and fescue.

Thus, at the beginning of the second year we had pure fescue for early and late grazing (fescue with applied N grows at cooler temperatures than clovergrass); ladino clover and fescue in mixture for late spring, early summer and fall; summer annual grass for hot weather grazing; and some accumulated fescue for winter picking. Also, most of them had some Coastal bermudagrass for hay or corn or sorghum for silage.

Grazing management was prescribed in accordance with research results and was followed to a closer degree than we anticipated. In some cases cattle were moved off one area and on another (rotation grazing) as plants were grazed down or from one species to another. On other farms the cows had access to all species at any one time, if sufficient growth were available (if some species, such as ladino or fescue, were under stress, they were

shut off those fields). There was some tentative indication that the latter system may give better animal performance.

In all situations we weighed the cattle as they went on the fields for the new grazing season and weighed them off at the end of grazing. Where practical, we weighed them on and off each species as they were moved, thus getting the contribution of each segment of the system. In any case, we knew the acreages involved, the number of days grazed and the weight gained or lost.

One of the major aims of the system was to improve summer gain of calves. This was extremely important where fescue was the predominant forage since the beef herds on performance test had shown very little calf gain, and in many cases an actual loss of weight, during the hot season. During 1968 the system, which includes species that grow best in hot weather, produced summer gains on one farm, as an example, of 2.10#/day on steer calves and 1.69 #/day on heifers (or 1.92#/day ave. for group).

Records were kept of inputs - labor, machinery, lime, fertilizer, etc. The best cases were, and are, those that are on the electronic business records program. We are trying to get more on this. Records are kept on sales, inventory, etc.

Also, we would emphasize that the key man is the agent and that all of these demonstrations are carried out cooperatively by personnel from the Crop Science, Animal Science and Economics Departments. Further, we were very careful to select cooperators who had been on the beef performance testing program for at least five years. Consequently, after carrying this program for five years we feel that we will have a good comparison and a real good tool to show beef producers that they can make money if they do the job right and that they should do the job right or get out.

We, of necessity, have not been able to carry very many demonstrations of this type since we are still doing single-shot demonstrations, variety testing, meetings, preparation of publications, teaching, etc. We have concentrated these in two districts (of six) where interest is high with two to three demonstrations per district. Some of these have gone two years (starting the third now) and agents in other districts are asking for this type demonstration. This is beginning to do what we wanted it to do - get people asking for it, then they'll carry it through.

In summary, we will give you the results of one farm where we have records for two years. This is an example, a good one, of what can be done and what we would like to do with each one. This man had expressed his intention to go out of the beef business. After consultation he decided to give it one more try. Following two year's results he has started an expansion program in beef cattle.

"May his tribe increase."

